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VOL. V WASHINGTON, D. C., JULY-AUGUST, 1924 No. 25

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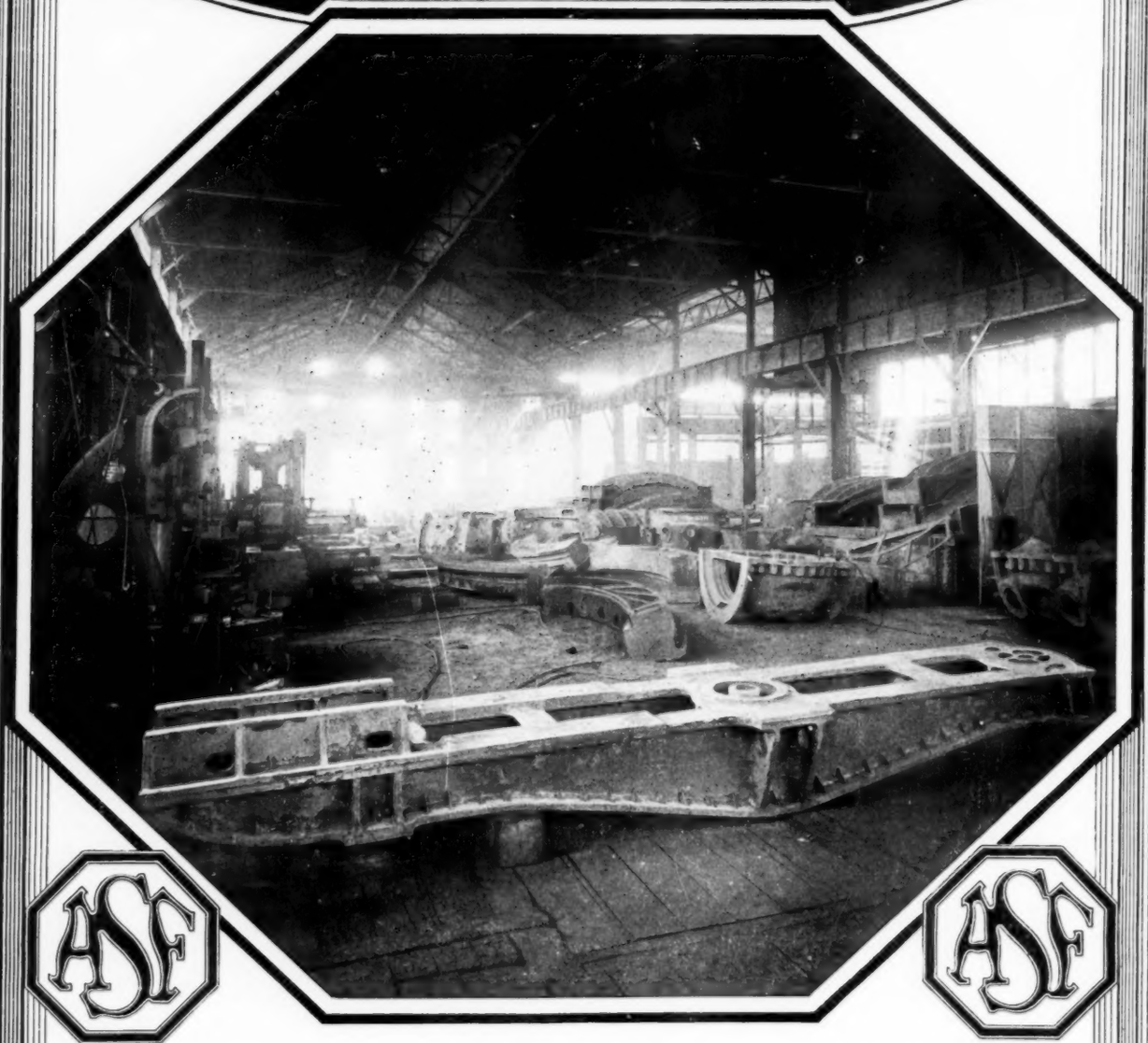

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ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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Published bi-monthly by the Army Ordnance Association at 410 Munsey Building, Washington, D. C. Subscription: $4.50 per annum in advance, Foreign countries, $5.00 per annum in advance. Single copies 75 cents. Advertising rates on application.

Entered as second-class matter August 14, 1920, at the post-office at Washington, D. C., under the Act of March 3, 1879.

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized September 17, 1920. Address all communications to the Secretary, Army Ordnance Association, 410 Munsey Building, Washington, D. C.

Printed by THE SERVICE PRESS, 423-425 G St., N. W., Washington, D. C.

Procurement Plans Tested in War Game

War Department Conducts Successful Practice Mobilization of Supply Branches

IN order to test the Industrial Preparedness plans made during the past few years a "Procurement War Game" was held in the office of the Assistant Secretary of War during the week of April 29th to May 3rd, 1924.

Being the first attempt to hold a war game of this nature there was doubt in the minds of some as to its final success but the results proved to be beyond all expectations. It has been decided that, in future, a Procurement War Game will be held each year.

All of the officers on duty in the Planning Branch, Office of the Assistant Secretary of War, and the student officers attending the recently established Army Industrial College, a total of 21 officers, participated in the game.

Each officer was assigned as the head of one of the divisions or sections on the war-time organization. One problem was given out each day, the afternoon being devoted to the working up of individual solutions for presentation on the following morning. A session was held each morning at which problems were read, solutions were given by the sections concerned, and a general discussion followed.

The first problem required each division of the office to state its mission, organization, the names and qualifications of executive and technical personnel, clerical personnel by designation, numbers, and grades and the floor space and office equipment required. Other problems were given in the nature of fictitious telegrams, memoranda, etc., outlining difficulties encountered in the field which required decision by the office of the Assistant Secretary of War.

These problems concerned such matters as securing funds to cover the placing of contracts promptly after "M" day, space requirements in Washington, the removal of legal restrictions which would embarrass the procurement program, methods of securing an adequate supply of strategic raw materials, such as manganese, tin, optical glass, etc., and special situations in connection with power, labor, price control, and transportation difficulties. The war game covered the first thirty days of war and presumed American control of the sea during that period.

Following this, war games were held by each of the seven supply branches in Washington for one week during which time the war game set up in the Assistant Secretary's Office continued to operate in order to assist the supply branches as requested.

Committees have been formed to study the points developed in the game and make recommendations as to any weakness brought out in the war plans.

Editorials

The Proposed New Constitution

COPIES of the proposed new Constitution of the Army Ordnance Association were recently sent to all voting members of the Association for approval. For the benefit of those who, under the present Constitution, are not permitted to vote—included in which class are all honorary members and those who are in any way connected with the Government service—we take this opportunity of outlining the present status of the matter.

At a meeting of the Board of Directors on February 29, 1924, the following resolution was adopted:

"RESOLVED, That a committee of three members be appointed to draft a revision of the Constitution and By-Laws; that this Committee be authorized and instructed to submit its proposed revised Constitution to the individual directors and to the several Posts of the Army Ordnance Association for comment and criticism; that, after such comment and criticism have been received, and final drafts of the Constitution and the By-Laws have been approved by the President of the Association, they shall be submitted to the Board of Directors by letter ballot; that, after approval by a majority of the Board, the proposed Constitution shall be submitted to the membership by letter ballot and, if approved by a majority of the ballots returned, it and the proposed new By-Laws shall become effective and supersede those now in effect."

A committee, composed of Col. James L. Walsh, Chairman, Colonel R. P. Lamont, and Major R. H. Somers, prepared the proposed new constitution which differs from the old chiefly in the following respects: (1) the grade "Honorary Member" is merged into that of "Member"; (2) Local Posts are formally recognized and provision is made for their representation upon the Board of Directors.

Since the polls close on June 30 we are unable at this writing to announce whether the proposed new Constitution has been adopted. Result of the vote will be published in the next issue of ARMY ORDNANCE. If adopted, the new Constitution will also appear in the next issue as well in the Yearbook of the Army Ordnance Association which will be issued shortly and furnished all members.

The Cleveland Meetings of Ordnance District Chiefs and A. S. M. E.

ELSEWHERE in this issue is published an account of the recent meeting in Cleveland of the Ordnance District Chiefs coincident with the Spring meeting of the American Society of Mechanical Engineers.

One can draw many conclusions from the announcement of such gatherings not the least of which is this: Industrial preparedness is claiming the time and attention of thinking men more and more as the days pass by. The psychological apathy that always follows in the wake of a great catastrophe is gradually beginning to wear away and we begin to acknowledge that the question of national security is not the ethereal will-o'-the-wisp subject some would have us believe it to be. It is one of the most vital issues confronting us as a nation and it is gratifying to know that there is a nucleus of our citizens who are convinced of its importance.

Plans are now under way to expand the present Ordnance Section of the A. S. M. E. to a National Defense Section of that body. This is a welcome announcement. It will mean that the functions of the present section which have been so helpful to Ordnance will be broadened to include all phases of preparedness so that all other questions of defense will be equally considered by this great engineering organization. While it may seem to be a loss to the cause of Ordnance the objectives sought and the ends to be obtained warrant the proposed change. It is to be hoped that the National Defense Section of the Society will be as successful in furthering the things of national defense in general as the Ordnance Section has been in the field of the design and development of Ordnance.

The Sixth Annual Meeting

THE Sixth Annual Meeting of the Army Ordnance Association will be held at Aberdeen Proving Ground on Friday, October 3, 1924. The meeting this year, while covering the whole field as heretofore, will especially emphasize the contributions of chemistry to National Defense. The Chemical Warfare Service as well as the Institute of Makers of Explosives and the American Insitute of Chemical Engineers will participate. Invitation will be extended also to the members of the eastern sections of the American Chemical Society.

There will be many new events at the meeting to claim the interest and attention of all those who have attended the meetings in the past as well as plenty to interest those who will be with us for the first time. The Program Committee has been at work for several months and this meeting will be quite different from any of those of the past. The general program will be printed in the September-October number of ARMY ORDNANCE.

All members of the Association are invited and urged to attend. This should be one of the largest gatherings we have ever had. Let us make the necessary arrangements now so that nothing will interfere with attendance and let each one of us make it a point to BRING A NEW MEMBER TO THE MEETING.

Industrial Preparedness

IN a very interesting letter published in *The New York Times*, June 17, 1924, Mr. Grosvenor Clarkson, author of "Industrial America in the World War," who served as Chairman of the Advisory Commission of the Council of National Defense and also as Chairman of the Inter-Departmental Defense Board, has this to say about Industrial Preparedness:

"Modern war is seven-eighths industrial. Soldiers can be improvised, relatively speaking, but huge industrial war

dispositions and conversions cannot be, without waste staggering in its proportions and consequent profiteering.

"The only cure is a scientific industrial preparedness. It can be had for less than the peace-time annual upkeep of a regiment of cavalry. The writer, seeking official funds, so stated to at least two different sets of Congressional appropriation committees on several occasions after the armistice, and had the figures to prove it.

"Industrial preparedness holds no romance. It would pay for itself over and over again by its peace-time benefits to industry, but the people even now do not understand war save in terms of troops and waving flags. That is one reason why we are now paying so heavily for our war-making.

"It is unintelligent to blame political parties for unpreparedness. It is the people themselves who have always been responsible. Always believing that we shall have no wars, we have gone on having them without preparation. For years we said that we should never need to fight overseas. Even now it is being said again to applauding audiences, and scarce five years have passed since we had two million fighting men in Europe!

"With regard to industrial preparedness a reasonable amount of sound argument by those in authority would help, if such argument be made articulate to the ear of the nation. Adequate industrial preparedness—the organized, synchronized economic power that makes irresistible the cutting edge of the sword—would have saved us possibly $5,000,000,000 in the last war."

Here is a strong statement from a man who stood close enough to the helm during the War to know whereof he speaks. Less informed and less interested citizens would do well to heed his salient statement.

The Army Ordnance Association, while certainly not among "those in authority" to whom Mr. Clarkson refers, has been endeavoring for the past five years to "make articulate to the ear of the nation" the sound argument for Industrial Preparedness. It has made good progress but there is yet much to be done. The difficulty seems to be that the ear of the nation is not always as receptive as it should be.

Who's Who in This Issue

MAJOR General C. C. Williams, whose testimony before the Senate Committee on Agriculture and Forestry concerning the Muscle Shoals offers appears in this issue under the title: "The Offers to Develop Muscle Shoals," needs no introduction to our readers. He has been Chief of Ordnance since early in January, 1918, and under his direction the great Nitrate Plants were constructed. He is therefore well fitted to discuss any plans which look toward their future status. His statement to the Committee is in his characteristic logical and clear manner. It should be of interest to every one who is concerned with adequate national defense.

Major H. K. Rutherford has written on a very important—and, we believe, little known—topic in his article: "Optical Glass: A Strategic Raw Material." Major Rutherford has spent much time and effort in mastering the optical glass situation here and abroad. He was formerly in charge of optical instrument development and manufacture at Frankford Arsenal. He is now a student officer at the Harvard School of Business Administration at Harvard University.

Major J. B. Rose, who writes on "The Application of Recuperator Mechanisms to Field Gun Carriages" is Chief of the Artillery Division, Office of the Chief of Ordnance. He has long specialized in gun and carriage design and is one of the foremost authorities on these subjects in this country. His article is a clear presentation of a highly interesting topic.

Major L. D. Booth describes the system of "Ordnance Stores Control," a subject of importance both to Reserve Officers and to civilians. He tells how the Ordnance Department with its great manufacturing plants and warehouses distributes its wares to "consumers" throughout the world. Major Booth helped inaugurate this system in France with the A. E. F. and he has had a great deal to do with its installation and operation in the Department in this country. It is a big job to supply Ordnance to the using services and Major Booth describes the necessary machinery in an interesting way.

Major G. P. Wilhelm, Chief of the Small Arms Division, Technical Staff, Office of the Chief of Ordnance, describes the epoch-making tests of the latest Browning invention, the 37mm. automatic gun developed by Mr. John M. Browning and manufactured by the Colts Patent Firearms and Manufacturing Co. Major Wilhelm was present at the test and is enthusiastic in his praise of the latest product of the Browning-Colt forces.

"War Contracts" is a detailed account of the War Department plans for standardization of contracts for the purchase of supplies during war, including all items of Ordnance matériel by Major John G. Booton, Executive Assistant to the Chief of Ordnance. Major Booton has been in charge of contracts and contract settlements in the Ordnance Office during the past few years and his viewpoint represents practical deductions from actual experience.

Mr. H. S. Beckman, author of "The Elements of Firing Table Construction," is engaged in this important work at the Aberdeen Proving Ground. He has devoted most of his time since the World War to the computation of range tables and his account of the *modus operandi* should be of interest to those less gifted in the ways of higher military mathematics.

Dr. H. H. Lester, who writes on "Crystal Deformation in Cold-Worked Steel" is a physicist on the staff at the Watertown Arsenal Testing Laboratory. The subject matter of his article is of great importance in ordnance development. In this connection attention is invited to an article by Dr. Lester which appeared in January-February issue of ARMY ORDNANCE, Vol. III, No. 16, page 210, on "The Radiography of Metals."

The article on "H. M. T. D.—A New Detonating Explosive," is the joint work of Mr. C. A. Taylor and Mr. W. K. Rinkenbach of the Bureau of Mines. Mr. Taylor is an explosives chemist of the Bureau and has been in charge of the Explosives Testing Laboratory at Pittsburgh since 1920. Mr. Rinkenback has been on the staff at the Pittsburgh station as an assistant chemist since 1919. Both authors are well known writers on explosives subjects. They are the joint authors of "Explosives, Their Constitution and Analysis," Bulletin 219 of the Bureau of Mines.

Cadet Frank L. Lazarus who stood high in the graduating class of 1924, United States Military Academy, contributes a thoughtful paper on "The Origin and Development of Weapons." We take pleasure in publishing this work of Cadet Lazarus not only because of its intrinsic value but also because it is an indication of the sound philosophic reasoning with which the graduates of West Point are equipped. The illustrations are the work of a classmate of the author, Cadet H. D. Vogel.

The Offers to Develop Muscle Shoals

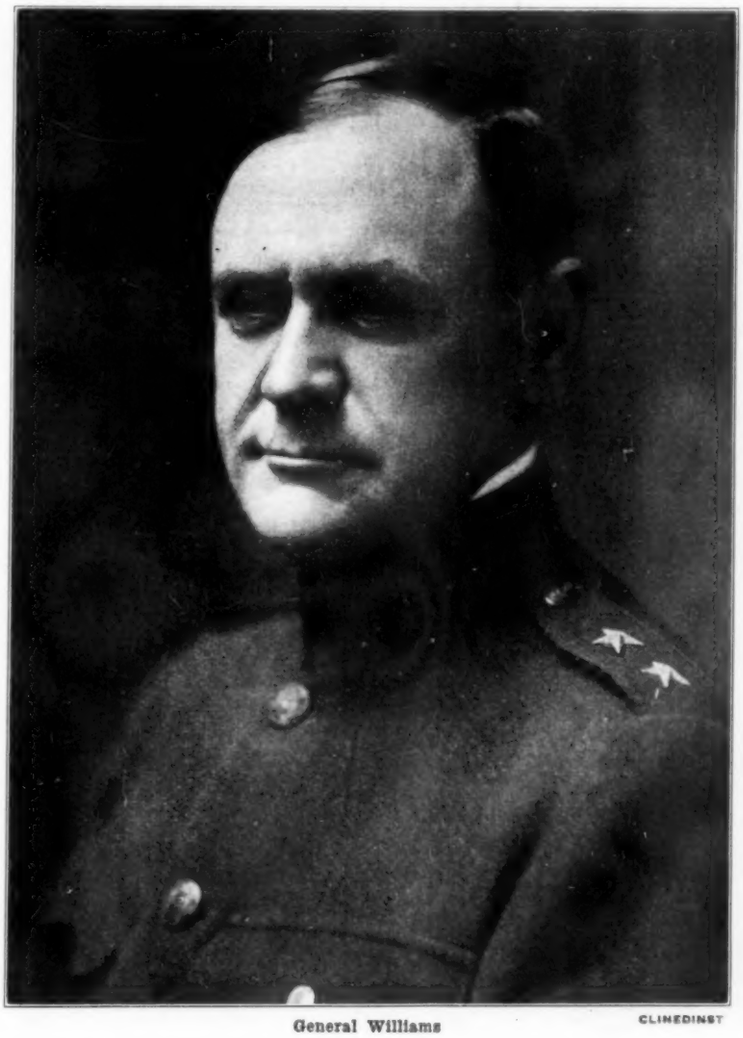
By

MAJ. GEN. C. C. WILLIAMS
Chief of Ordnance

During the recent hearings on the various offers for the development of Muscle Shoals before the Senate Committee on Agriculture and Forestry, General Williams, at the request of the Chairman, made the following analysis of the several proposals which the Committee had before it. General Williams' statement is published here for the information of those who are interested in this much discussed and important preparedness problem

IT is my understanding that the Committee desires a statement of my views on the comparative value of the various proposals which have been submitted.

I find that it is very difficult to draw a definite and accurate comparison between these offers, due to the fact that no uniform plan has been used in their preparation. I believe that it will be best to consider them from three standpoints: (1) Military preparedness, (2) Financial return to the Government, (3) Fertilizer provisions.



General Williams CLINEDINST

In regard to the first I would say that the problem of military preparedness seems to me to be the simplest of the three. It is my opinion that a final solution of this phase of the problem is to be found in the development of a commercial nitrogen industry along the lines of private manufacture. Very substantial progress is being made along this line and I would like to call attention to the fact that production of ammonium sulphate equivalent from coke oven and gas works has increased from less than 200,000 tons in 1914 to more than 600,000 tons in 1923. This is approximately three times the capacity of U. S. Nitrate Plant No. 2. This increase has had the effect of changing the United States from an importer of some 83,000 tons of ammonium sulphate in 1914 to an exporter of 165,000 tons in 1922 and 168,000 tons in 1923. At the time of the Armistice there was only one small commercial nitrogen fixation plant operating in the United States. Since that date three additional plants have gone into operation so the importance of the Nitrate Plants from the standpoint of military preparedness is growing less, from year to year, and I believe that the maintenance of Nitrate Plant No. 2 which is now necessary for military preparedness will become entirely unnecessary in less than twenty years. With the addition of the Begg amendment to H. R. 518 (the Ford Bill) all the offers will meet the requirements of National preparedness.

I will now take up the second basis of consideration, *i. e.*, financial return to the United States. A study has been made in my office and covers the Ford offer, the combined power companies' offer, the Hooker plan and the Union Carbide Company's plan. The results of this study are shown in the tabulation on the next page.

The Committee will realize that quite different assumptions may be made on which to base estimates and correspondingly different totals will be reached. However, in making the comparison every effort has been made to put the figures as nearly as possibe on a uniform and fair basis.

Method of Comparison.—The period covered has been limited to 50 years following completion of Dam No. 2.

No interest, simple or compound, on payments to the

FINANCIAL RETURN TO UNITED STATES OF THE SEVERAL PROPOSALS
(Figures cover period of 50 years.)

	Ford Offer (interest on $34,000,000 on Dam No. 2)	*Power Company's Offer, Dams Constructed by U. S.*	*Hooker Plan*	*Union Carbide Company's Plan*
Dam. No. 2	$64,538,384	$87,600,000	$85,479,940 (Includes No. 2 Steam Plant)	$28,324,200
Dam. No. 3	49,841,000	47,809,320	27,794,798	
No. 2 Steam Plant		4,500,000	(Included with Dam No. 2	
U. S. N. P. No. 2	1,527,512			7,500,000
U. S. N. P. No. 1		(Less maintenance expense, U. S. N. P. No. 2, 50 years—$5,000,000.)		
Waco Quarry				750,000
Total	$115,906,896	$134,909,320	$113,274,738	$36,574,200*

* This figure is not comparable with the totals for the Ford, Power Company, or Hooker proposals since the Union Carbide Company's offer is for only a fraction of the property.

United States has been computed. The fertilizer agreements of the various offers are not compared because there is no definite basis upon which a comparison may be made. It should be noted that in the case of the Hooker plan and in the case of the Union Carbide Company's offer, should fertilizer be made at a loss, the loss will fall upon the Government and that therefore the figures shown in the table will be reduced by that loss, if any.

In dealing with Mr. Ford's figures there is deducted from the $5,000,000 that he would pay for the Nitrate Plants, the sum of $3,472,488, since this sum would be expended by the Government in building a new steam plant on the Warrior River.

In establishing figures for Mr. Hooker's offer, nothing is included for revenues on additional facilities which it is proposed should be constructed at Government expense. His plan to increase the size of the No. 2 Steam Plant has been disregarded. This is done for the reason that no proper comparison can be made with such a considerable variation in the property as is involved in the United States expenditure of $6,000,000 to double the size of the steam plant.

In establishing figures for Mr. Hooker's plan, the value of the power is taken from the tabulation made in the Hearings of 1922 before the Senate Committee on Agriculture and Forestry on S-3420. These figures appear in the testimony of Major J. H. Burns, Ordnance Department, and are contained in pages 914 to 920.

Assumptions:

1. Cost of Dam No. 2 complete—$51,000.000.
2. Cost of Dam No. 3 complete—$37,331,000.
3. Dam No. 3 to be completed three years after Dam No. 2.
4. There remained $34,000,000 to be expended on Dam No. 2 on May 31, 1922, $17,000,000 having been expended prior to that date.
5. There will be no income to the United States from the manufacture of fertilizer.
6. The steam plant at U. S. Nitrate Plant No. 2 will be sold to the power companies for $4,500,000.
7. The power companies will expend $5,000,000 during the fifty years in maintenance of the U. S. Nitrate Plant No. 2, this amount to be deducted from rent payments.
8. The Union Carbide Co. would use power as follows:
   25,000 h.p. primary;
   13,100 h.p. ten months power average;
   11,900 h.p. eight months power average.

9. The income from sale of power under the Hooker plan will be in accord with estimates made in the Ordnance Office (see Hearings of 1922 on S-3420, Senate Committee on Agriculture and Forestry, pages 914 to 920).

In estimating the return from the Hooker plan reference has been made to figures appearing in the testimony of Major J. H. Burns in hearings before this Committee in 1922 on S-3420. According to this estimate the expected net return from the sale of power would be as follows:

Dam No. 2, including steam plant	$116,513,789.00
Dam No. 3	37,686,536.00
	$154,200,325.00
Less maintenance expense, U. S. N. P. No. 2, 50 years	$5,000,000.00
Net income to United States for 50 years	$149,200,325.00

Comparable figures for the three offers would therefore be as follows:

Power Company's offer	$134,909,320
Ford offer	115,906,896
Hooker plan	113,274,738

At this point special attention should be called to the fact that the figures under the Union Carbide Company's plan are not comparable with the totals under the other plans, due to the fact that the Union Carbide Company's offer involves only a part of the power and the use of a part of Plant No. 2, leaving to the Government the disposal of other items of value. This plan is predicated on operation of the hydro-electric project by the Government or some other agency, and the $36,000,000 shown in the above tabulation would be but one item in the total receipts of the Government which would be a larger sum.

In connection with the Power Company's offer, it might

be said that the total, as shown in the above tabulation, of approximately $135,000,000 might possibly be increased by several million dollars should it be possible to lease Nitrate Plant No. 2 in such a way as to make it self-sustaining.

It would appear therefore that the greatest financial return to the Government would be obtained in the following order:

The Power Company's offer,
The Ford offer,
The Hooker offer.

The offer of the Carbide Company, being for a part of the property only, cannot be directly rated with the others.

Fertilizer Production.

In regard to the third basis for consideration, that of fertilizer production, I would like to generalize briefly on the situation before attempting to make any comparison of the offers.

The feasibility of producing nitrogenous fertilizers by fixation of atmospheric nitrogen for use under American conditions is still open to doubt. While the United States is a heavy importer of Chilean nitrate, it has also become an exporter of ammonium sulphate, this latter material being representative of a class of materials most generally produced by nitrogen fixation. The nitrogen fixation plants which have been established in this country are producing ammonia for the high priced refrigeration or chemical trade, and have not, as yet, entered the low priced fertilizer market. If the products are to be of any material benefit to the farmer, they must be sold at prices lower than those as yet attained. At prices existing four years ago it seemed quite probable that U. S. Nitrate Plant No. 2 could be operated for fertilizer production on a self-sustaining basis. At that time ammonium sulphate was selling in excess of $100 per ton. Since that time ammonium sulphate has sold as low as $40.00 per ton and is now quoted at $53 per ton, which is somewhat less than one-half of the price four years ago. Four years ago acid phosphate was quoted at $19.00 per ton and is now $7.50 per ton, which is materially less than one-half of the price during 1920. I have quoted these figures to illustrate the uncertainty of the fertilizer market which has, no doubt, been carefully considered by everyone offering to undertake production at Muscle Shoals. There is a chance of a heavy loss being incurred in guaranteeing to produce a fixed quantity of fertilizer.

I will now mention the various proposals which fall into two general classes:

(1) The Union Carbide Company's plan and the Hooker plan are alike in that the Government will furnish the capital for the fertilizer operations, takes all of the losses, should there be any, and a part of the profits under the Hooker plan or all of the profits under the Union Carbide Co. plan, should the business prove profitable. They are also alike in that both offers are made by concerns having wide experience in chemical manufacture and either would therefore be in a position to apply to the business experience of undoubted value.

The Hooker plan provides that a sum of $50,000 per year be set aside from the net profits when a reasonable sale of power from Dam No. 2 is made for use in research and experimental work. At a time when a reasonable sale of power shall be commenced from Dam No. 3 this sum will be increased to $200,000 per year.

Since the Government will receive two thirds and later three-fourths of the net earnings, these proportions of these sums will be advanced by the Government. In addition, it is required that the Government will duplicate these amounts.

The offer of the Carbide Co. provides nothing for research.

The Hooker plan provides that the Corporation shall furnish such power as is needed for actual nitrate and fertilizer production at Plants Nos. 1 and 2 from time to time out of power then available from sources under lease from the United States and not previously sold, and of such character as the Secretary of War may require. To this end the Corporation will hold available for the United States on reasonable notice up to one-fourth of the developed primary power capacity of the Steam Plant at Nitrate Plant No. 2 and from Dam No. 2 and from Dam No. 3 when completed; and in addition will hold available on similar notice developed secondary power from Dams Nos. 2 and 3 up to 100,000 k. w.

The offer of the Union Carbide Co. is of such nature that it can make no reservation of power for the manufacture of fertilizer.

The amount of fertilizer to be manufactured under the Hooker plan is indefinite.

The amount of fertilizer to be made under the Union Carbide Co. plan will have a maximum nitrogen content of approximately 20,000 tons per year.

It is my opinion that both of these plans are undesirable. These are cost plus contracts.

(2) The Ford plan and that of the Power Company are alike in that they both agree to finance the fertilizer project and to make fertilizer at a limited profit, bearing the losses if any. It is inconceivable that either company would continue indefinitely to manufacture a material which could be sold only at a loss, and it is still doubtful if nitrogen fertilizers can be made at a profit by present fixation methods.

The Ford plan does not stipulate a definite sum to be expended in research and experimental work.

The Power Company's plan stipulates that $1,000,000 to be paid in ten years will be used for research and experimental work.

The Ford offer contemplates the manufacture of 40,000 tons of nitrogen per year and the amount of power used in the manufacture of fertilizer will be that required to produce this amount.

The Power Company's offer provides for initial installation and manufacture of 5,000 tons of nitrogen per year. Should this undertaking prove successful, they will expand the production of nitrogen until it reaches the sum of 50,000 tons per year. This offer provides that 60,000 h. p. from Dam No. 2 and 40,000 h. p. from Dam No. 3 will be sold at cost for use in the manufacture of fertilizer. It also provides that an additional 40,000 h.p. will be reserved for sale to manufacturers of fertilizers at the prices and terms prescribed by the Federal Power Commission.

It is felt that from the fertilizer production standpoint all the offers are of uncertain value. The offers cannot be rated in this respect because there is no similarity among them.

There are, of course, a number of points in each offer that I have not commented upon as it seemed necessary to cover only the salient features.

Browning 37-mm. Automatic Guns

By

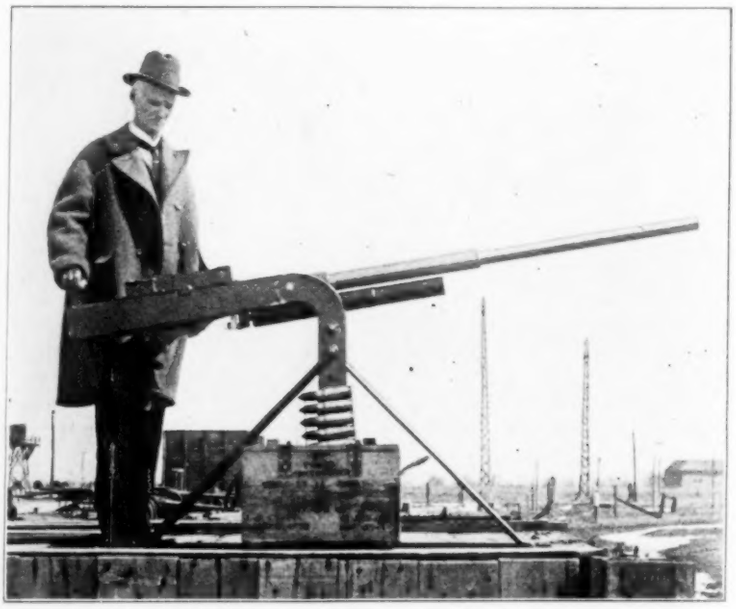
G. P. WILHELM

IN the presence of a number of Army and Navy Ordnance officers Mr. John M. Browning, the noted gun inventor, demonstrated his new 37-mm. Browning automatic gun at Aberdeen Proving Ground, Maryland, on April 2.

The demonstration included firings of two of these guns, alike in design but, due to difference in power (one being built for a muzzle velocity of about 1,300 f. s. and the other for 2,000 f. s.) considerably different in length and weight.

The firings included the use of the guns with barrel in a vertical position, in a horizontal position, elevated to 45°, and depressed to 45°, as well as a certain amount of firing with the gun upside down and on its side. Both guns functioned perfectly.

The demonstration given by Mr. Browning becomes an event of importance when the military value of this achievment is recognized. For a great many years, it has been the goal of inventors and engineers to produce a practical automatic gun firing an explosive projectile weighing not less than one pound. In the Boer War there was used the famous "Pom Pom," which was nothing more or less than an overgrown Maxim machine gun. The "Pom Pom" received its name from the characteristic sound of firing. From a military point of view the "Pom Pom" was not successful, by reason of its great weight and its low velocity.



John M. Browning and His New 2,000 f. s. Automatic 37-mm. Aircraft Gun

During the World War the old idea of the "Pom Pom" was used again, and several guns firing one-pound shells were seen on both sides, the Germans particularly using an automatic 37-mm. which was similar in design to the German Maxim but, of course, was very large.

All of these various types of weapon were fed by means of a belt, to which there were some objections in the larger calibers. The new Browning guns are fed by clips and are capable of delivering a rate of fire of about 100 to 150 shots per minute.

The design is distinctly different from that of Mr. Browning's well-known machine gun, although both guns are based on the same general principle, i. e., recoil of the barrel.

There are three military uses for guns of this type. First, for the Air Service as an aircraft automatic gun in the armament of planes for use against ground targets, as well as other types of Air Service targets. Second, as an antiaircraft weapon; a gun of the same general type, with higher velocity, would be most effective as an antiaircraft weapon. Third, as an Infantry gun, as it is possible that an automatic 37-mm. gun with lower muzzle velocity and less size and weight, would become a very satisfactory weapon for this extremely important purpose.

The entrance of Mr. Browning into the field of larger caliber automatic guns is of great interest to the Army and Navy. In the past these two branches of the service have relied for their automatic pistols and for some of their most effective small caliber automatic guns, such as the Browning machine gun and the Browning automatic rifle, on the Colt's Patent Fire Arms Manufacturing Company, with which Mr. Browning is connected. The Colt Company, as well as Mr. Browning, are to be congratulated upon their entry into the design of larger caliber automatic weapons and upon their initial success.

Among those present at the test were Mr. John M. Browning, the inventor; Mr. S. M. Stone, President of the Colt's Patent Fire Arms Manufacturing Company; Mr. F. T. Moore, Works Manager of the Colt's Patent Fire Arms Manufacturing Co.; Brig. Gen. C. L'H. Ruggles, Chief of Manufacture, Army Ordnance Department; Brig. Gen. J. W. Joyes, Chief, Technical Staff, Army Ordnance Department; Colonel W. H. Tschappat, Commanding Officer, Aberdeen Proving Ground; Commander H. Delano, Navy Department; Lieut. Commander G. L. Schuyler, Navy Department; Lt. Col. C. M. Wesson, Executive Assistant to the Chief of Manufacture, Army Ordnance Department; Major Earl McFarland, Commanding Officer, Springfield Armory; Major Lee O. Wright, Chief, Small Arms Division, Manufacturing Service, Army Ordnance Department and Major G. P. Wilhelm, Chief, Small Arms Division, Technical Staff, Army Ordnance Department.

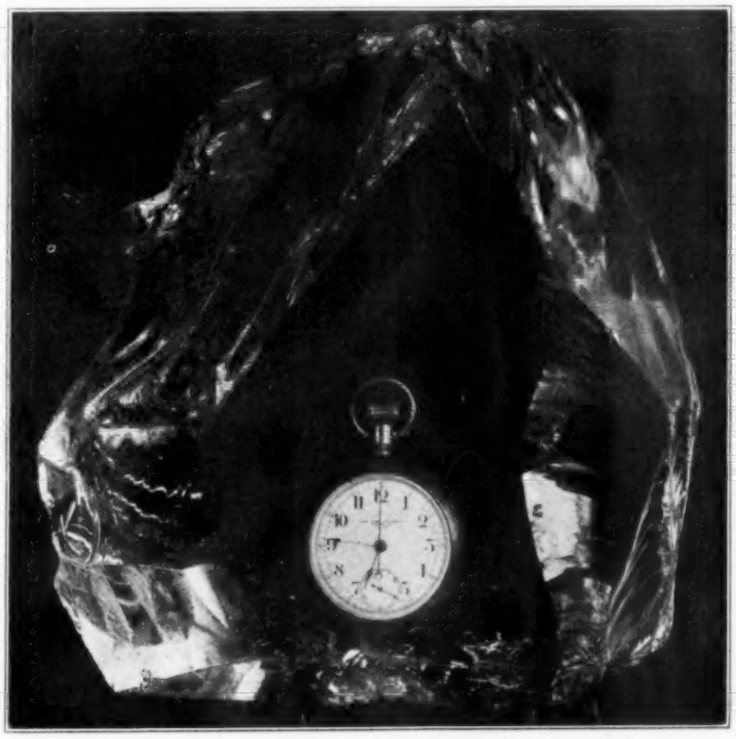
A 37-mm. automatic gun has been an objective long sought by inventors and engineers. It now seems an accomplished fact.

Optical Glass: A Strategic Raw Material

By

H. K. RUTHERFORD

FIRE control instruments comprise a great variety of devices and apparatus such as range finders, gun sights, binoculars, telescopes, computers, etc., used in the determination of firing and other data required for the service of modern weapons. A considerable number of these instruments require optical glass in their construction, and since this commodity is quite difficult to manufacture, it may prove the limiting factor in production, as was the case in the early stages of the World War. Optical glass is, however, used commercially for a great number of purposes, as, for example, in the construction of binoculars, cameras, many kinds of industrial apparatus, surverying instruments, moving picture projectors and microscopes. Fire control equipment is in daily use by our Army to an extent depending upon the latter's size and activity. Instruments of a similar character are in daily use by the Navy, as well as many others of a highly specialized character for which the Army has no need. With the exception of a few minor items, fire control instruments have no commercial uses. Fire control equipment, in general, is as essential to both Army and Navy as are the weapons themselves. Some of the items making up the complete equipment are, of course, more essential than others, since there is no need of improvising substitutes. In the order of their importance, they may be arranged roughly in classes as follows:



A Piece of High Transmission Optical Glass Four Inches Thick

(a) Of first importance: Gun sights; certain observation instruments, such as binoculars, battery commander's telescopes, azimuth instruments and aiming circles; fuze setters; plotting boards for seacoast artillery, etc.

(b) Of lesser importance: Self-contained range finders; range and deflection correction devices; plotting boards for mobile artillery.

(c) Of minor importance relative to the above: Trench periscopes; magnetic compasses; declinators; draftsmen's instruments and other equipment of the topographical engineer.

Optical glass is an indispensable component of certain fire control instruments and the need for it in wartime is vital.

Source of Supply

The manufacturing resources of the United States are ample to provide all fire control equipment and optical glass needed by both Army and Navy during a war of major importance, in addition to the other demands made on them during that period, provided the industry be properly organized and directed.

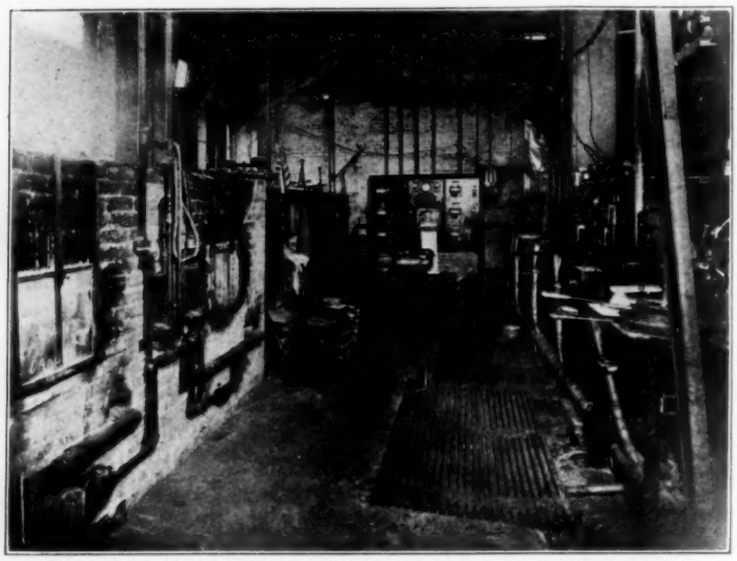
At the present time, there are a few commercial concerns, such as the Bausch & Lomb Optical Company, Spencer Lens Company, Keuffel & Esser, Wellensaek Optical Company, Central Scientific Company, and others, which have had more or less experience in this work. As time passes, their war experience will be forgotten except in the case of a few of them whose commercial work is quite closely related to that of fire control instruments. In the case of a future major emergency, therefore, the number of experienced commercial concerns available for work on fire control instruments will be small, as it was at the outbreak of the World War.

The Instrument Department at the Frankford Arsenal is prepared to manufacture, in small quantities, any of the fire control instruments needed by the Army, and maintains in peacetime laboratories for development work and for the study of the best means of manufacturing these instruments.

Since the manufacturing capacity of Frankford Arsenal is only a small percentage of the total required production of instruments in wartime, its function is properly that of a laboratory, where development is to be carried on, methods of manufacture determined, and drawings and specifications prepared, which information

is to be kept available for distribution to commercial concerns when necessary in an emergency.

The maintenance of the Instrument Department at Frankford Arsenal with the most modern manufacturing and laboratory equipment is thus one of the most important items in preparing for the manufacture of fire control instruments in quantity. By properly distributing the information accumulated there, as well as its skilled personnel, to suitable outside concerns, the latter will be enabled to produce acceptable instruments with a minimum loss of time and with a minimum of labor, even though they may have had no previous experience with them. In this manner, our domestic resources may be developed from those concerns which have had no experience in this particular line of work. Because of the very limited number of firms having experience on fire control, and the fact that they have insufficient capacity to meet our needs, this method appears to be the only one promising any degree of success.



The Optical Glass Pressing and Annealing Room at Frankford Arsenal

The rough pieces of glass are here heated, pressed into shape, and annealed to relieve the stresses caused by the pressing. This equipment makes possible the utilization of irregular shaped pieces of glass and reduces the amount of work to be done in the later stages of manufacture.

Our domestic resources for the production of optical glass, including both supplies of the raw ingredients and manufacturing capacity, are more than ample for all our wartime needs. The large glass producing plants are now, however, practically shut down on account of lack of demand and the fact that glass may be imported more cheaply from abroad. This is not a satisfactory condition from a military standpoint, and will be referred to more in detail later.

The normal domestic production of the major items of fire control equipment in peacetime is ordinarily quite small, being limited for the most part to the manufacture chiefly at Frankford Arsenal of experimental types for test and the providing of standard equipment for such new types of ordnance as may be developed.

Fire control instruments are exported to a limited extent in peace time. Certain of the South American republics have, at various times, procured such items of coast defense as plotting boards, Lewis depression position finders, deflection boards, etc., from commercial firms in this country. In 1915-1916, some thousands of battery commander's telescopes, short base range finders and gun sights were exported to England, Russia and France by manufacturers in this country, as well as many thousands of binoculars.

Up to 1915, practically all of the optical glass used in this country was imported either from Germany, France or England. The foreign supply was cut off by the war, thus necessitating the development of our own resources. Since December, 1917, we have had sufficient domestic resources for all needs, both war and peace, but, as above stated, these resources are not being used to any great extent at present. Optical glass is again being imported.

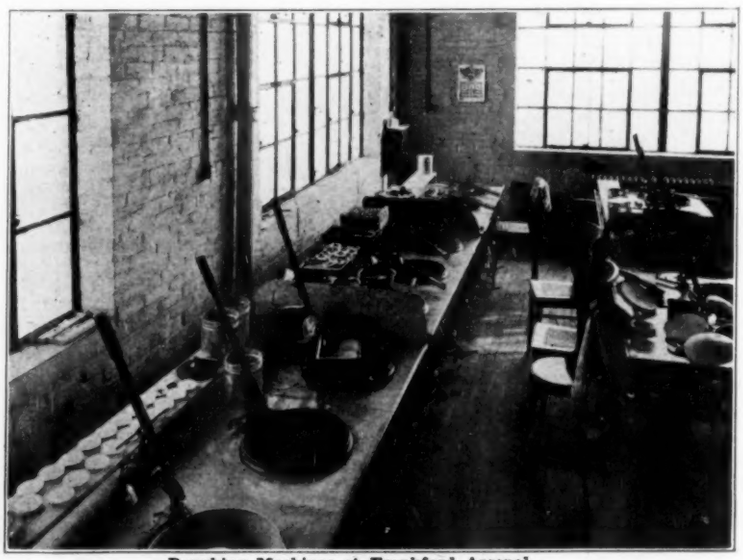
The most practical means of providing, in an emergency is, as outlined above, to make possible the utilization of the facilities of commercial concerns by distributing to them skilled personnel and manufacturing data from Frankford Arsenal, as covered more in detail below. This would, of course, apply only to concerns which have had little or no experience in the manufacture of fire control instruments.

The capacity for the manufacture of optical glass in this country is now ample for all needs.

The limiting factors in the production of fire control instruments during the late war were as follows in order of importance:

(a) Lack of knowledge on the part of manufacturers in regard to methods of manufacture and proper appreciation of the grade of workmanship required.

(b) Lack of sufficiently skilled personnel for the manufacturing, assembling and inspecting operations.



Roughing Machines at Frankford Arsenal

This is an important stage in the manufacture of lenses. Here the previously pressed and annealed parts are ground to approximate size and shape.

(c) Lack of special machinery needed for the expeditious performance of certain of the operations.

(d) In the early part of the war, lack of certain raw

materials, especially optical glass.

(e) The necessarily complicated character of some of the instruments, making manufacture a slow process.

(f) Lack of knowledge on the part of government inspectors as to what was required of the manufacturer, resulting in much friction and delay in production.

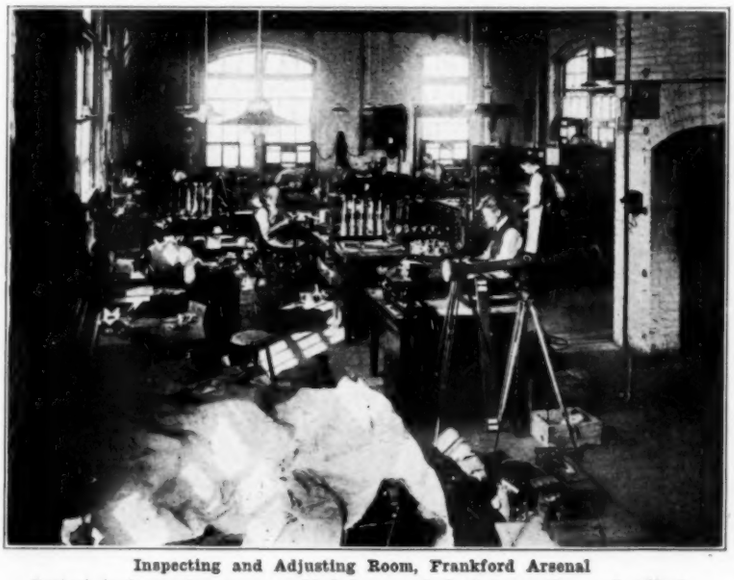
(g) Lack of a central office to which contractors or inspectors could apply and obtain immediate authoritative information on any point in question.

The factors which limited the supply of optical glass during the late war are enumerated in Ordnance Department Document 2037. Briefly, they were lack of knowledge of the art and lack of facilities.

The foreign sources of supply of importance for fire control apparatus and optical glass are Germany, England and France, and, to a lesser extent, Belgium and Holland.

England has excellent facilities for the production of self-contained range finders of any size in quantity. France is an excellent source of supply for optical glass, finished optical parts and for certain finished instruments, particularly those pertaining to antiaircraft fire control. Belgium and Holland, due to the establishment therein of branches of the large German optical shops, will become an increasingly valuable source of supply.

The capacity of the manufacturing plants in Germany make it possible to obtain fire control instruments from that source, both optical and non-optical, as well as optical glass in any quantity likely to be required. England could supply all our needs as regards self-contained range finders, in case of necessity. In the late war, England was not entirely self-sustaining in regard to fire control equipment.



Inspecting and Adjusting Room, Frankford Arsenal

Optical instruments are assembled here and final inspection and adjustment is made. The room is well adapted for the purpose being elevated above all surrounding buildings so that ample light and view can be obtained.

The productive capacity of France is likewise capable of great increase in case of necessity. France, during the late war, was entirely self-sustaining in regard to fire control equipment, and, in addition, furnished large quantities to the United States and other allies.

World War Requirements

Great difficulty was experienced during the World War in obtaining a supply of optical glass and production of many essential items was seriously delayed on this account. The difficulty was due to the fact that there were practically no sources of supply in this country, the processes of manufacture were not known, and no glass could be obtained from abroad because of the great demand for it. This problem was solved for all time and this country made self-supporting in this regard by the development of the processes of manufacture and providing of facilities for production in this country. During the late war, the total value of the Army and Navy orders for optical munitions was over $65,000,000, of which about $50,000,000 was for the Army.

Optical Glass

Each of the pieces shown weighs approximately nine hundred pounds. The specimen shown at the upper right is twenty inches thick and still permits a clear view through it.

Instrument manufacture necessitates the use of highly skilled machinists, toolmakers, or instrument makers, for a few of the most important machine operations, of less skilled workmen for the rougher work, of semi-skilled assemblers for the preliminary assembling operations and of highly skilled workmen for the final assembling, adjusting and inspecting of the completed article. The supply of labor skilled in instrument manufacture is very small even in peacetime, and, in wartime, is impossible to obtain, chiefly due to the fact that this country is generally accustomed to import its instruments and has developed few facilities and little skilled personnel for the work. This fact necessitates the utilization of any available skilled or suitable unskilled labor and training it to perform the operations required. Naturally, the greater the skill of the workman in his own line, the easier he finds it to become proficient in a related line. For example, toolmakers and high grade

machinists quickly become good instrument makers and watch makers soon qualify as good instrument assemblers. It is possible to train unskilled workmen to perform certain of the required operations with success and the use of automatic machines further reduces the need of skilled operatives. However, the design of the instrument rarely lends itself to production on automatic machines, and the work will always require the services of a large proportion of high grade mechanics. The final operations of assembling and adjusting especially require the services of skilled operatives, who are, however, not necessarily toolmakers or machinists.

Practically all of the labor required must be skilled to some extent in one or more of the operations. Approximately 10 per cent of the whole force should be mechanics of the highest grade; 50 per cent mechanics of ordinary ability or workmen skilled on some particular minor operation, and the remainder unskilled workmen trained to perform some one of the less important operations.

A considerable increase in the number of so-called skilled mechanics occurred during the war, but the ability of a large number of them was far from satisfactory. They could, in many cases, however, be trained to perform certain of the required operations, and consequently there was no shortage in the semi-skilled labor class in this industry.

The experience of the late war showed that workmen skilled in instrument manufacture or any phases of it were extremely hard to find and that it was essential that those so engaged should be exempted from draft. Likewise those engaged in training for the work should be exempted if of sufficient ability to warrant their being continued on it. Furthermore, workmen who are skilled, or partially so, in some art which would render them more adaptable than usual for training in instrument work, should likewise be exempted provided they take up some essential work of this nature.

Production was not curtailed by lack of power during the war. The coal shortage effected a few plants temporarily, but this condition was soon relieved.

In this connection, it should be stated that the demand on the part of the optical glass plants for illuminating gas for the furnace will be very considerable in war time, as is shown by the fact that the situation became serious in this respect during the coal shortage in the winter of 1917-1918. In producing a quantity of 52,000 pounds of optical glass, approximately 33,000 cubic feet of gas are required. Since the production of optical glass in October, 1918, was 80,000 pounds, which quantity is probably fairly representative of the maximum monthly war requirements, it appears that about 51,000,000 cubic feet of illuminating gas will be required for this industry alone in an emergency.

Domestic Manufacturing Facilities

Following is a list of the most important existing domestic facilities for instrument or optical glass manufacture:

(a) Frankford Arsenal, Philadelphia, Pa. (Complete instruments.)

(b) Bausch & Lomb Optical Company, Rochester, N. Y. (Complete instruments and optical glass.)

(c) Spencer Lens Company, Buffalo, N. Y. (Complete instruments and optical glass.)

(d) Keuffel & Esser Company, Hoboken, N. J. (Complete instruments and optical glass.)

(e) Pittsburgh Plate Glass Company, Charleroi, Pa. (Optical glass.)

(f) Bureau of Standards, Washington, D. C. (Optical glass.)

(g) C. P. Goerz American Optical Company, Southbridge, Mass. (Finished optical parts.)

(h) Central Scientific Company, Chicago, Ill. (Complete instruments.)

(i) Eastman Kodak Company, Rochester, N. Y. (Optical parts.)

(j) Kollmorgan Optical Company, Brooklyn, N. Y. (Complete instruments.)

(k) Wollensak Optical Company, Rochester, N. Y. (Complete instruments.)

The above firms are the principal ones capable of manufacturing instruments containing optical parts. In addition to those listed, there are numerous machine shops which are capable of producing non-optical instruments in quantity when properly guided. Among the more important of those who did good work during the war are Atwater Kent Manufacturing Company, Philadelphia, Pa.; Recording & Computing Machines Company, Dayton, Ohio, Emerson Engineering Company, Philadelphia, Pa.

Frankford Arsenal alone had capacity for not more than 5 per cent of the total requirements of fire control instruments for the Army in the late war. Since that time its capacity in this regard has been doubled, which represents nearly its limit of expansion without unwarranted expenditure. Its present output is approximately 25 per cent capacity, except on repair work, where it is about 50 per cent of its present capacity for this kind of work.

As a rule, only standard tool equipment is required for instrument work. Since the work is in small pieces, small precision machines are most suitable, but for some of the coarser work great accuracy is not so necessary. As a general rule, however, the equipment must be accurate and be kept in good condition to obtain a satisfactory output.

Conservation

The only practicable method of conserving the supply of fire control instruments is to repair them whenever possible and return to service. This method is now habitually followed, and facilities are provided with armies in the field to permit this to be done.

The supply of optical glass may be conserved to a considerable extent by proper methods on the part of the glass manufacturers and users. Much glass will be saved if lenses and prisms are pressed to approximate size instead of being cut from a slab. Much glass can be saved if arrangements are provided to press into shape the numerous irregular-shaped pieces left from each pot. Most glass manufacturers now have such facilities, but their use should be extended by requiring all optical glass delivered to be pressed to approximate size for the work intended.

The Frankford Arsenal, which has been engaged in the manufacture of fire control instruments for many years, has detailed information regarding production methods on all classes of this material. Complete drawings and specifications of all parts including optical systems are also kept on file ready for issue, as well as those for raw material, including optical glass. Improved methods of manufacture are continually being made at this establishment, which is endeavoring to keep abreast of the best practice in instrument manufacture, and so that it may be in a position to instruct others in case of necessity. *(Continued on page 487.)*

Application of Recuperator Mechanisms to Field Gun Carriages

By

J. B. ROSE

A GUN is as much a machine for generating power as is a gasoline engine. There is, however, but one explosion, which is of immense power. The potential energy of the powder charge is in a small fraction of a second converted into the kinetic energy of the projectile, the powder gases, the recoiling parts and into heat. If we take, for example, a gun of 6-inch caliber, which we may call a gun of medium size, and fire from it a projectile weighing 108 lbs. with a muzzle velocity of 2,600 ft. sec., the energy of this projectile as it leaves the muzzle is about 11,340,000 ft. lbs. As this energy is developed in 15 thousandths of a second, it means that in terms of horsepower the gun develops 1,375,000 horsepower during the brief time it is in action.

These figures are given merely as an example of the energy which must be considered when we mount such a power machine on its carriage. It will be found in practice, however, that we are not so much concerned with this horsepower or energy as with the actual forces acting on the recoiling parts and the energy imparted to them. In a gun of the size indicated, the cross-section of the bore is 28.9 square inches, and the maximum powder pressure 38,000 lbs. per square inch, which gives a pressure of 1,100,000 lbs. acting on the breech block of the gun.

If the gun were held stationary in firing, it would be practically impossible to mount it on anything except a very heavy solid foundation, and a mobile or portable carriage of any reasonable weight would be altogether impracticable.

It therefore becomes necessary to allow the gun to recoil upon its carriage a certain distance, since by so doing the force of the powder gases finally transmitted to the carriage becomes relatively small. This follows from the fact that the force of the powder gases which is an impulsive one is converted into an incessant force. The intensity of the impulsion is $\int_0^T F\,dt$, but this is measured by the momentum of the masses acted on by F, i. e., the force of the powder gas. The momentum of the recoiling mass, M V is constant for a given intensity of impulsion regardless of its mass. However, since it is the energy of the recoiling mass, $M V^2/_2$, which the carriage must dissipate, this energy is greatly reduced if we increase M as this results in a corresponding decrease in V, since MV= constant. But V being squared we gain by decreasing it at the expense of M.

In the case of the gun mentioned, if we allow it to recoil a distance of 18 inches, its movement can be checked by a force of about 80,000 lbs. acting throughout the length of recoil, and if we care to allow a greater length of recoil, this force would be correspondingly decreased. It is very evident that if the carriage structure were designed to meet the previously indicated force of the

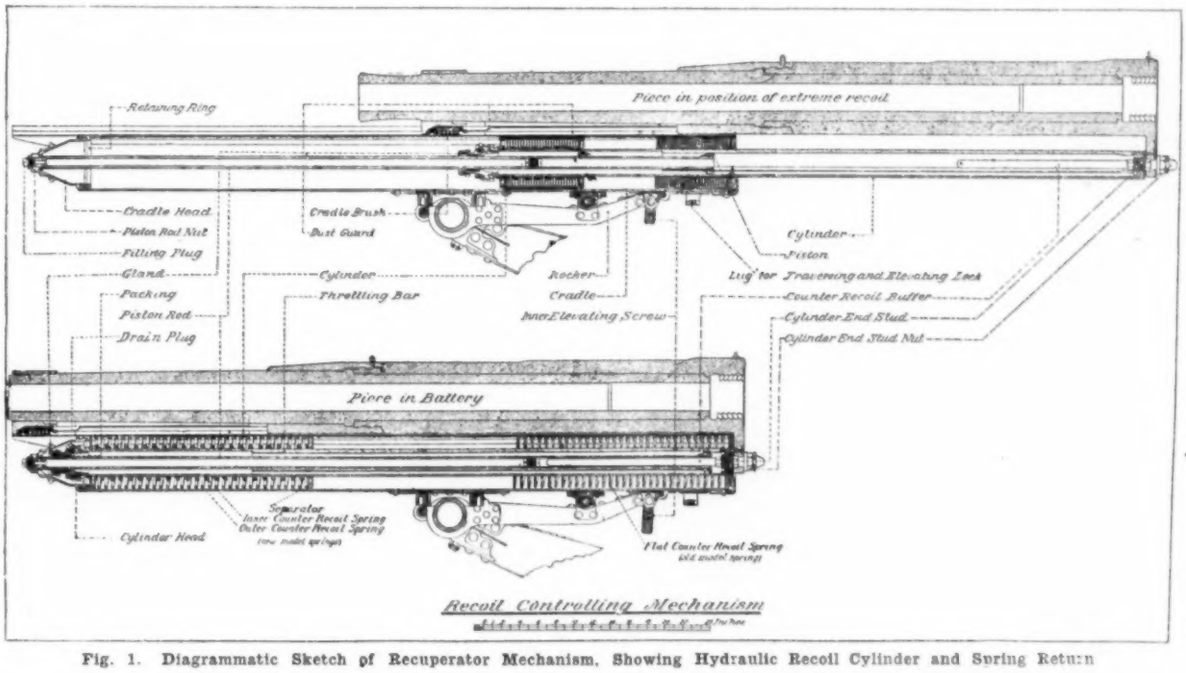


Fig. 1. Diagrammatic Sketch of Recuperator Mechanism, Showing Hydraulic Recoil Cylinder and Spring Return

For many centuries guns were mounted on carriages which recoiled as a complete unit, the movement being checked by ropes, wedges, or other obstacles interposed, and it was only near the end of the last century that any efforts made to allow a portion only of the carriage to recoil resulted in practical results. It seems that in about 1895 springs were introduced in the trail of certain field carriages which allowed a slight movement of the carriage, but without ultimate change of position as the springs forced the recoiling parts back into position. The real application of a true recoil system to field carriages seems to have been effected in about 1897 by the French, although it is known that experiments were under way for some time prior to this. Application of a recoil system to heavy guns in seacoast fortifications was made a few years prior to this date. On the whole, the hydraulic recoil is a very modern development, and is practically contemporaneous with that of the automobile.

Surprising as it may seem, the recoil and recuperator mechanisms introduced by the French in their 75-mm. field gun carriage, Model of 1897, have not been improved upon except perhaps to a moderate degree. This does not mean that interest and experiment in the development of recoil carriages have been dormant; on the contrary, every military power has developed numerous types of these mechanisms, and the effort to obtain a light, simple and smooth working machine has been continuous.

To discuss the mechanism which we have in mind, it will be best to divide it into two parts and consider each separately—first, the mechanism which controls recoil of the gun as it moves to the rear, and secondly, the mechanism which regulates its return to the firing position. In actual construction these two are intimately connected, in fact the connection is so intimate that the expression "recuperator," that is the counter-recoil mechanism, is used quite frequently to designate the entire assembly.

Construction of the recoil mechanism proper has never given great difficulty, once thoroughly understood. It is only necessary that the piston attached to the recoiling parts shall force the oil or fluid through an orifice of such size that the necessary pressure will be developed, this orifice being made either constant or variable, as may be desired. In the case of the heavier types of cannon mounted in fixed emplacements, it has not been very difficult to control the counter recoil, at least until the recent introduction of high elevations, as in these heavy rigid structures it is not very objectionable if the movement in counter recoil is relatively rapid, as the stability of such carriages is not involved. In the case of field carriages in which weight is restricted to a minimum for the sake of mobility, the problem of the recoil and recuperator system is more difficult. To obtain the lightest possible construction it has been necessary to allow a recoil of about 45 inches or more on various types of field carriages, and to secure the maximum of stability with minimum of weight, effort is made to vary the resistance to recoil in proportion to the changing stability of the carriage as the gun recoils. Even in such carriages the design of the recoil system is not in any unusual degree difficult, and it is to the design of the recuperator system that most efforts have been devoted.

It has been indicated that the recoil system tends to greatly reduce weight of matériel and that it also increases the stability of a gun carriage in firing. It is difficult to say which of these two improvements is the more important. The old type carriage which jumped about violently after each round fired did not permit continuous and rapid laying of the piece, as it was necessary to repeat after each round every operation for aligning the gun both in elevation and in traverse. It was also impossible for the gunner to keep his eye at the sight on account of the violent jump. Fire at moving targets was practically out of the question as far as any accuracy was concerned.

Although the principles of calculating the forces acting during recoil were well understood, it appears that a true physical conception of the advantages of long recoil as against a short recoil developed very slowly. In about 1902 comparative tests of several types of 3-inch field gun carriages were made by the Ordnance Department, and carriages having both a long and short recoil were tried out. There was expectation on the part of some at least that the short recoil carriages would be entirely satisfactory. This may have been due to the fact that the importance of absolute immobility of the carriage was not then so greatly emphasized.

In order that a carriage be stable it is necessary that the moment of the weight of the carriage about the center of pressure at the end of the trail must be greater than the total resistance to recoil multiplied by its lever arm about the center of pressure of the trail. Other things being equal, the stability therefore varies directly with the resistance to recoil, and this resistance to recoil again varies inversely with the length of recoil. Experience has shown us that in the case of field carriages the best compromise between weight and stability can be obtained with a recoil of about 45 inches, this length increasing somewhat with the caliber. It may be added that development of a so-called muzzle brake may ultimately permit a considerable reduction in this length of recoil with a decrease in the total weight.

The types of recoil and recuperator mechanism used on field gun carriages, for the purpose of this discussion, may be roughly divided into 3 classes. We have first the hydraulic recoil cylinder, associated with a spring column. The recoil is checked by the recoil cylinder assisted by the spring column. The gun is returned to its initial position by the springs, the movement being regulated by a type of spear buffer, which is nothing more than a long dash pot, and by the slight resistance of the oil passing back through the orifices necessary to control recoil. This type of mechanism is shown in Fig. 1.

A second class consists of a hydraulic recoil cylinder as before, but the energy required for returning the gun into battery is stored up by compressing air or nitrogen, which is in immediate contact with the oil. In the actual application of this system it is customary to have one cylinder control the recoil and act as a regulator against violent counter-recoil, and to provide two additional cylinders, one of them being the reservoir for air and the other containing oil which is forced by a piston into this reservoir, thus compressing the air and storing up the energy necessary for counter-recoil.

The third class consists of a hydraulic recoil cylinder as before, but the oil passing from this cylinder under pressure of the piston does not come in direct contact with the air, the two being separated by so-called free or floating piston. This type of mechanism may probably be considered as representing the highest development. The theory of its construction is quite simple, but its manufacture and assembly are, on the other hand, quite an art.

It may be of interest to specify some of the ideal characteristics of a recoil and recuperator mechanism for field gun carriages, as by so doing we can identify the virtues as well as the defects of the three classes indicated. First consider the question of recoil. If we are firing a gun

horizontally or at low elevation, and the carriage is kept to a minimum weight, it is necessary that the resistance to recoil shall vary as the stability of the carriage. As the gun recoils, the center of gravity of the whole unit moves to the rear, and the resistance to overturning about the trail end decreases. The resistance to recoil should decrease proportionately. This can be very easily accomplished in the spring return mechanisms, which we have called class 1, by constructing a variable orifice for the oil. It may also be effected in the class 2 mechanism, which uses a variable orifice. In the class 3 mechanism, as we are now designing it, the orifice in recoil is controlled by a poppet valve. This orifice is therefore constant provided the pressure is sufficiently great to hold the valve entirely open. During recoil the friction resistance and the air resistance both increase, and it is therefore only possible by careful design to obtain a curve of decreasing total resistance to recoil.

Fig. 2. The American 75-mm. Gun Carriage, Model 1921 E, Left side View, 45° Elevation. Mounting the Gun on Trunnions Close to Its Breech Permits Use of Constant Length of Recoil.

It is desirable as far as consistent with the requirements of changing stability to obtain a recoil system in which the pressure is practically uniform. If uniform pressure is maintained, it means the cylinder need not be designed to resist temporary peaks in the pressure curve, thus possessing strength greatly in excess of that necessary during other points of recoil. This uniform pressure tends to minimum weight of construction. Classes 1 and 2 lend themselves readily to a uniform pressure. The class 3 mechanism with the poppet valve control introduces a high peak at the beginning of recoil. If the valve is given sufficient throw to reduce the pressure occurring at the time of maximum velocity of retarded recoil, the valve opening would be too great to develop the desired pressure near the end of recoil when the velocity has slowed down. Fortunately the friction and air resistance builds up toward the end of recoil, and a high oil pressure is not necessary at that time. The valve can therefore be made to take care at least in great part of the high velocity at the beginning, thus avoiding an objectionable peak in the curve.

It has been necessary to introduce the variable recoil system (that is, one in which the length of recoil automatically shortens as the gun elevates) in order that the breech of the gun may not strike the ground at high elevations, or to avoid digging a pit in order to clear this breech. The use of a variable recoil considerably complicates the mechanism, and it is far preferable to avoid it wherever possible. In a number of the new designs of field carriages, the gun is mounted on trunnions very close to its breech, and this in some cases has permitted use of a constant length of recoil. The new American "75" shown in Fig. 2 is an example. Incidentally, if the recoil is kept constant, the piston rod pull can be kept within more reasonable limits at the high elevations, and this tends to reduce the weight of the carriage as it may be designed for lower stresses.

The importance of perfect control of counter-recoil, particularly in connection with field carriages has been noted. The retardation on return into battery must be as nearly uniform as possible, as this permits design of matériel having a very slight preponderance at the trail end. It is necessary to keep the weight at the trail end quite low so that the carriage can be shifted easily by hand to make large changes in fire direction. In the case of the 75-mm. matériel it has been considered desirable to keep this weight less than 100 lbs. Under such conditions a violent counter-recoil would tip the carriage over forward. This tendency is aggravated in modern matériel since it is necessary to make the counter-recoil system powerful enough to return the gun into battery at extreme elevation, and it necessarily follows that at low elevations, control of counter-recoil must be very carefully adjusted. In view of this, the counter recoil in all new types of matériel is checked throughout the movement into battery, and it has been necessary to discard the old type of spear buffer, which enters a dash pot only in the latter part of counter-recoil.

A recoil system must either be so constructed that it will function almost indefinitely without attention, or so that it can be easily dismounted and repaired in the field. The most highly developed types of modern systems meet the first requirements if manufactured with extreme care and carefully adjusted. They fall short of the second requirement, however, as with the exception of a few simple adjustments, it has not been found practicable to overhaul them in the field in a satisfactory manner.

Preparedness Plans Explained at Pittsburgh

INDUSTRIAL preparedness plans in Pittsburgh were given great impetus on the occasion of a recent visit of Hon. Dwight F. Davis, the Assistant Secretary of War, to that city on April 15th. During his visit Colonel Davis addressed over 500 members of the local Chamber of Commerce at luncheon, and over 1,600 engineers and executives at a mass meeting at the William Penn Hotel.

An excellent account of Colonel Davis' visit was given in the *Pittsburgh Post* of April 16th, 1924, as follows:

"Dwight F. Davis, Assistant Secretary of War, urged utmost preparation in all military departments as the best preventive of another war, in two addresses here yesterday, one to the Pittsburgh Chamber of Commerce members at the noon luncheon, and the other to members of the Associated Engineering Societies of Pittsburgh in the William Penn Hotel last night.

" 'Pittsburgh during the last war furnished more than 60 per cent of all metal supplies we needed,' he said.

" 'When we realize that Pittsburgh's iron and steel production is equal to that of Britain and all her colonies, that your tonnage is twice the total of New York, London, Liverpool and Marseilles, we know what a tremendous factor this industrial district is in any war planning.

" 'While we do not believe there is any danger of war, we know there is a possibility of war at anytime. That is what we are trying to plan against. This is not preparation for war, but preparation against war, because we hope to make this country so strong that any nation will hesitate to attack.'

Cost of Unpreparedness

" 'Unpreparedness has cost us millions of dollars and many lives in previous wars, and the War Department is determined we will never commit again the criminal folly of being caught unprepared.

" 'Because you have an important part in our plans I want to ask your hearty, sincere cooperation. It is the biggest business proposition of any country, the mobilization of all industries in emergency.

" 'If you had to expand your business 50 times, you would have a serious problem getting raw materials, many of which come from foreign countries and would be difficult to get.

" 'This problem is the problem of industry itself, of preparing itself to meet the emergency. We have set up 14 procurement districts with headquarters in principal industrial cities. Pittsburgh is one headquarters.

" 'We shall draft prominent business men as district chiefs. We divide the requirements according to the districts, allotting each what it produces in peace time. The idea is to make tentative contracts with manufacturers and give them plans and specifications.

" 'We are working on a standard contract form and we plan that, on the outbreak of an emergency, telegrams may be sent to these 14 district chiefs and from them radiate to 10,000 factories. Each manufacturer then can take from his safe his plans, specifications and contract and get to work next day.'

"Mr. Davis was introduced by President A. L. Humphrey of the chamber.

Engineers Hear Talk

"President A. W. Thompson, of the Philadelphia Company, introduced Davis to 1,400 members of the Associated Engineering Societies of Pittsburgh who gave him an ovation in the William Penn Hotel last night.

"These organizations participated: The Engineers' Society of Western Pennsylvania, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Chemical Society, American Society for Steel Treating, American Electrochemical Society, Illuminating Engineering Society, American Society of Civil Engineers, Society of American Military Engineers, Ninety-ninth Division Organized Reserves, U. S. A., and the American Association of Engineers."

California Post, A. O. A., Elects Officers

THE recently established California Post of the Army Ordnance Association held its first election of officers in San Francisco on May 17, 1924. The following were elected:

President: P. E. Holt, 1520 North Eldorado Street, Stockton, California, General Manager Holt Tractor Company, (on duty in the Ordnance Department in Washington 1917-1918).

Vice President: C. N. Black, 58 Sutter Street, San Francisco, California, President, Market Street Railways (formerly Colonel, Ordnance Department, U. S. A., 1917-1919).

Directors (term expiring November 30, 1925): Fred Boegle, Jr., First National Bank Building, Oakland, California, Secretary, California Manufacturers' Association; Bruce Cornwall, 57 Sutter Street, San Francisco, California, of Coldwell, Cornwall, and Banker, Chief, San Francisco Ordnance District, 1923 (formerly Lieutenant Colonel, Ordnance Department, U. S. A. 1917-1919); J. C. Scrugham, Carson City, Nevada, Governor of Nevada (formerly Lieutenant Colonel, Ordnance Department, U. S. A. 1917-1919); D. C. Seagrave, Santa Fe Building, San Francisco, California, President, Pacific Coast Shipbuilding Company (formerly Colonel, Ordnance Department, U. S. A. 1917-1919).

(Term expiring November 30, 1926): W. E. Creed, Balfour Building, San Francisco, California, President, Columbia Steel Corporation, President, Pacific Gas and Electric Company; D. C. Jackling, Hobart Building, San Francisco, California (on duty in charge of Government powder plants by special appointment of the President during the War); W. H. Oliver, Fourth and Madison Streets, Oakland, California, Vice President and General Manager, Oliver Continuous Filter Company, Oakland, California; C. H. Shattuck, 1585 Lombardy Road, Pasadena, California, Secretary, C. F. Braun Company (formerly Captain, Ordnance Department, 1917-1918).

The Post has also adopted a Constitution which prescribed the purposes and general form of the organization. Advantage has been taken of the action of the Board of Directors of the Army Ordnance Association with reference to Junior Membership and provides that "American citizens who are students at recognized engineering schools shall be eligible for junior membership while pursuing such courses of study as will enable them to fill subordinate positions in Ordnance work. Because of the large area and scattered membership of the Post, provision is made for the transaction of necessary business by correspondence and letter ballot of the Board of Directors or active membership as the case may be."

Ordnance Stores Control

By

L. D. BOOTH

THE Ordnance Stores Control System is properly limited to control of supplies as exercised by the Chief of Ordnance and his subordinate officers as distinguished from the control of Ordnance supplies exercised by Commanding Generals of troops through their General Staff and Ordnance Officers assigned to their commands. However, to show how control is exercised from the time an article is adopted as standard equipment until it is placed in the hands of using units a brief discussion is given on control of supplies by Commanding Generals of troops.

Prior to the World War, the Ordnance Department used the "Balance of Stores System" for controlling supplies under its direct supervision but immediately after the war the "Ordnance Provision System" was adapted in lieu of the "Balance of Stores System."

There are two basic requirements to be fulfilled in controlling supplies, one is that the quantities of supplies to be kept on hand or required must be established, and the other is that the necessary machinery or system be provided for obtaining reports as to the status of supplies and for transmitting orders for their movement.

The quantities of supplies required are fixed after computing the quantities needed as a reserve to meet the requirements of war plans and the quantities needed to meet the requirements of the several components of the Army of the United States for current replacement.

The War Department has directed the retention as a war reserve of all important special items of armament and has prescribed the stocks of reserve ammunition to be retained. In accordance with the Act of Congress—Appropriations for the Army for the fiscal year ending June 30, 1924, as published in Bulletin No. 4, W. D. 1923, page 45, the War Department is authorized to hold reserve supplies sufficient for the equipment of two field armies, or one million men. In applying this authorization the War Department is directing that the supplies be divided into two classes, viz, those that would be essential and which are special and difficult to produce and those that could be classed as non-essential or easily pro-

REVIEW SHEET

GROUP ..... ARTICLE ..... CLASS ..... SEC. .....

DATE	AUTH. RESERVE	A DUES OUT	B DUES IN	C STOCK	D ISSUES	E R FROM S	RECOMMENDED DEMAND	REMARKS
		222	222	222	222	222		
		222	222	222	222	222	222	
Dates of Review.	Minimum authorized stock of the item.	Colored figures represent quantity due out to other depots on transfer orders. Black figure represent quantity due out to the service.	Colored figures represent quantity due in from other depots on transfer orders. Black figure represent quantity due in from local procurement, from shipping orders on hand or from unserviceable material ordered repaired for stock.	Colored figures represent quantity due in from other depots on transfer orders. Black figures represent quantity in stock in unserviceable condition and not under repair for stock. Black figures represent quantity in stock in serviceable condition.	Colored figures represent quantity issued since last review to other depots on transfer orders. Black figures represent quantity issued to the service since last review.	Colored figures represent the quantity of unserviceable material returned to the Department since last review for its stock. Black figure represent quantity of serviceable material returned to the Department since last review, it having been previously issued by the Department.	Black figures represent the quantity of the item needed for replenishment of stock.	

Fig. 1. Review Sheet: the First Step in the Operation of the Ordnance Provision System

CONSOLIDATED REVIEW RECORDS

GROUP ..... CLASS ..... SEC. ..... CASE QUAN. ..... AUTH. RESERVE ..... ARTICLE .....

C/L QUAN. .....

DATE	(NAME OF DEPOT)								(NAME OF DEPOT)								TOTAL						REMARKS
	A Dues Out	B Dues In	C Stock	D Issues	E R from S	DEMANDED Amount	DEMANDED From	DEMANDED No.	A Dues Out	B Dues In	C Stock	D Issues	E R from S	DEMANDED Amount	DEMANDED From	DEMANDED No.	A Dues Out	B Dues In	C Stock	D Issues	E R from S	DEMANDED	Balance On Order	
Dates of Reviews	Colored figures represent quantity due out to other depots on transfer orders. Black figures represent quantity due out to the service.	Colored figures represent quantity due in from other depots on transfer orders. Black figures represent quantity due in from local procurement, from shipping orders on hand or from unserviceable material ordered repaired for stock.	Colored figures represent quantity in stock in unserviceable condition not under repair. Black figures represent quantity in stock in serviceable condition.	Colored figures represent quantity issued to other depots on transfer orders. Black figures represent quantity issued to the service since last review.	Colored figures represent the quantity of unserviceable material returned to the Department for its stock, since last review. Black figures represent quantity of serviceable material returned to the Department, it having been previously issued by the Department. since last review	Quantity demanded.	Depot from which item is to be shipped.	Transfer or shipping order number.									Colored figures represent total dues out to other depots and is sum of depot colored figures. Black figures represent total dues out to the service and is sum of depot black figures.	Colored figures represent total dues in from other depots and is sum of depot colored figures. Black figures represent total dues in to the Department which has been allocated to depots and is sum of depot black figures.	Colored figures represent total unserviceable stock not under repair and is sum of depot colored figures. Black figures represent total serviceable stock in the Department. (These totals are sums of like colors of depot columns plus any in transit between depots.)	No colored figure entries. Black figures represent total issues to the service since last review, and is sum of depot black figures.	Colored figures represent total unserviceable articles returned to Department since last review. Black figures represent total serviceable articles returned to Department since last review.	Black figures represent total quantity demanded by depots.	Black figures represent balance on order which has not been allocated to depots.	

Fig. 3. Consolidated Review Records: The Permanent Record Maintained in the Office of the Chief of Ordnance of All Ordnance Supplies for Storage and Issue

Date _____ **ABSTRACT OF REVIEWS** Depot _____

Group _____ Name of review _____

ARTICLE	Auth. Reserve	A Due out	B Due in	C Stock	D Issues	E R from S	Recommended Demand	REMARKS
This is consolidation from Review Sheets of items active since last review and quantities are transcribed therefrom.								
Items listed here in the order in which they appear on Standard Nomenclature List.	Minimum authorized stock of the item.	Colored figures represent quantities due out to other depots on transfer orders. Black figures represent quantities due out to the service.	Colored figures represent quantities due in from other depots on transfer orders. Black figures represent quantities due in from local procurement, from shipping orders on hand or from unserviceable material ordered repaired for stock.	Colored figures represent quantities in stock in unserviceable condition and not under repair for stock. Black figures represent quantities in stock in serviceable condition.	Colored figures represent quantities issued since last review to other depots on transfer orders. Black figures represent quantities issued to the service since last review.	Colored figures represent the quantities of unserviceable material returned to the Department since last review for its stock. Black figures represent quantities of serviceable material returned to the Department since last review, it having been previously issued by the Department.	Black figures represent the quantities of the items needed for replenishment of stock.	

IMPORTANT NOTE: If any other unit of measure than "each" is used, it will be written in parenthesis, after the name of the article.

Fig. 2. Abstract of Reviews: The Condensed Report of Reviews for Transmittal to the Chief of Ordnance

cured in case of emergency. It is the policy to then fix the two field Army requirements of essential items as the reserves to be maintained and to ask for appropriations to bring any shortages up to that minimum. This two field army requirement has been used as the basis by the War Department in figuring the maximum quantities of supplies which the Regular Army may keep on hand without making free issues to the other components of the Army of the United States.

Supplies held as a reserve are stored in reserve depots, manufacturing arsenals and in depots and arsenals which have been designated as the issue establishments for the Corps Areas. An arsenal which has been assigned the function of supplying the troops of a given Corps Area in peace also stores the necessary reserve supplies to equip the units to be mobilized in the area in case of an emergency. Entries of reserve supplies on stock record sheets are in accordance with instructions in the Ordnance Provision System Regulations.

The quantities of supplies to be kept for current replacement are figured from consumption data and each arsenal places on its stock record sheets the maximum and minimum for each article required for stock to supply the units of the Corps Areas assigned them for supply. The control or regulation of supplies to keep them up to the designated quantities is exercised through the Ordnance Provision System. This system operates through the use of the following special forms; Review Sheet (Fig. 1), Abstract of Reviews (Fig. 2), Consolidated Review Records (Fig. 3), and Transfer Order (Fig. 4) and Report of Stores (Fig. 5). This method, as must any system which provides and controls stocks from a central office, furnishes information as to stocks on hand at the different establishments, the issues made since last report and the demands for replenishment of stocks.

The provision system operates essentially as follows. The whole range of Ordnance articles is divided into a series of groups, each group containing major items of a similar character with the spare parts and accessories peculiar to each major item. Parts common to major items of two or more groups and all standard commercial items are placed in one group, designated Group "H". This collection of common items into one group is mainly for the purpose of economy.

Standard Nomenclature Lists are published showing the approved nomenclature for all items. Simple individual items and their parts of one group, such as bayonets, bolos, swords, etc., are covered by a single nomenclature list but the larger and more intricate major articles with parts and accessories have a nomenclature list for each major item. Stock record sheets are made out and filed strictly in accordance with the nomenclature and arrangement of the items in the nomenclature lists.

The Schedule of Reviews prescribes the dates on which items are to be reviewed. Each item is reviewed by all depots on the same date. The reviews are made in peace, semi-annually, and, in time of war, weekly, daily or even at shorter intervals, depending on the turnover of the items, together with their importance and difficulty of procurement. These reviews are so scheduled as to distribute the work involved as evenly as possible throughout the year. Special reviews are made as needed.

The Provision System operates in and between the Ordnance Office and establishments directly under the

ORDNANCE DEPARTMENT, U. S. ARMY

FIELD SERVICE

TRANSFER ORDER

WASHINGTON, D. C.

TO COMMANDING OFFICER

SHIP TO COMMANDING OFFICER

AUTHORITY TRANSFER NO.

QUANTITY	ARTICLES REQUIRED

SIGNED: APPROVED:

(Group Head) *(C. O. P. O.)*

NOTE—The consignee should address all inquiries concerning the date of shipment of material covered by this Transfer Order to the Consignor.

Fig. 4. Transfer Order: By Which Ordnance Supplies are Ordered from a Depot to the Using Service

control of the Chief of Ordnance. Section VII, Office Order No. 425, lists these establishments, which are: Augusta Arsenal, Benicia Arsenal, Hawaiian Ordnance Depot, Aberdeen Ordnance Reserve Depot, Erie Ordnance Reserve Depot, Charleston Ordnance Reserve Depot, Curtis Bay Ordnance Reserve Depot, Old Hickory Ordnance Reserve Depot, Philippine Ordnance Depot, Panama Ordnance Depot, San Antonio Arsenal, Delaware Ordnance Reserve Depot, Savana Ordnance Reserve Depot, Pig Point Ordnance Reserve Depot, Raritan Arsenal, Wingate Ordnance Reserve Depot, Ogden Ordnance Reserve Depot. In a depot these duties are performed by a unit of personnel especially designated for the duty.

A separate Review Sheet is maintained for each separate item just as are stock record sheets in the War Department Property Accounting System as prescribed in Army Regulations 35-6720. After the headings of the sheets are filled out the latter are bound into sets according to the order in which the names appear in Standard Nomenclature Lists. This is also the order in which stock record sheets are filed in the group ledgers by the group personnel. On the date specified for the review of a designated class of items the provision personnel takes the set of review sheets covering the items to the group office and transcribes the data from the Stock Record Sheets, Dues Out Sheets and Dues In Sheets to the Review Sheets. After a consideration of this data obtained from the group office, the quantities of the items needed for replenishment of stock are entered in the column headed "Recommended Demand." This completes the review. It will be noted that column "C" shows separately the serviceable and unserviceable stock on hand at the depot at the date of the review. The total issued to the service since last review is entered in black figures in column "D".

After completion of the review all the items in which there have been transactions during the review period are entered in the first column of the Abstract of Reviews and the data for the remaining columns are copied from like columns of the Review Sheets. The Abstract of Reviews, which is simply the condensed report for transmittal, is then mailed to the Ordnance Office. As the reports are received in Field Service they are sent to the groups concerned where the information is transferred to the Consolidated Review Record.

The Consolidated Review Record is the permanent consolidated record maintained in the Ordnance Office of all supplies which are assigned to the Ordnance Department for storage and issue. This record is made up, a separate sheet for each item, and bound into sets similar to the arrangement of the sets of Review Sheets. All depots storing an article are entered in the spaces pro-

REPORT OF STORES

No.

Date

From: Ordnance Office, Field Service,

To:

Subject: Deficit—Surplus

Article:

Symbol:

Balance of Stores on above named article shows a deficit—surplus of _____ (Quantity) _____ (Unit)

on _____ (Date), 19

This deficit is due to the cause below indicated as No.

1. Your failure to procure as per Requirements Schedule.
   a. Orders not placed.
   b. Orders placed but no delivery.
2. Requirements Schedule in error.
5. Equipment Lists in error.
4. Unusual issue as follows:

Our unobligated stock was _____ (Quantity) _____ (Unit)

Our average rate of issue is _____ (Quantity) _____ (Unit) per _____ (Period)

Receipt acknowledged.

Date:

Division

By: _____

FIELD SERVICE

BY

_____

Fig. 5. Report of Stores: the Notice to the Manufacturing Service to Procure or Manufacture Material

vided on the record. The columns for each depot are the same as those on the Review Sheet and the Abstract of Reviews. After entering on the Record the data from the Abstracts from all depots, the grand totals are then entered in the column provided.

The data shown in Column "D," the issues, are naturally of great importance since they show the total issues to the service by the Ordnance Department during a definite period of time. From this information is computed the stock needed to meet the current requirements of all components of the Army of the United States for a period of one year. In making use of the record of issues Field Service must naturally take into consideration the size and organization of the Army of the United States which the issues have supported, and also the proportion of such issues which have been made in initially equipping new organizations. Upon the completion of the organization of the Army of the United States according to the National Defense Act, the issues for new organizations will, of course, cease and all issues will become replacement issues.

The total stock assets of the Department would be the sum of the black figures in the "Dues In" column, the black figures in the "Stock" column and the figures in the "Balance on Order" column. Since the "Dues In" is that which has been allocated to depots and the "Balance on Order" is that ordered but not yet allocated to depots, the above sum is the total stock actually on hand or in prospect. Since one year's supply has been fixed as the minimum to be on hand and on order the total liability of the Department at any date would be the quantity for one year's supply plus the dues out black figures on that date.

Upon completion of the Consolidated Review Records for a given review a request for procurement, called the Report of Stores (Fig. 5), is made up including thereon these items quantities of which on hand and on order are near the minimum stock for one year's issues. The quantity ordered should be that necessary to bring the supply up to the maximum allowance for two years' supply. Whether the Manufacturing Service orders two years' supply or less depends on money available, difficulty of manufacture, advantages in price on large orders, etc. The Report of Stores may or may not give shipping instructions for the articles to be procured. The Manufacturing Service, after placing the order, forwards a copy of the Procurement Authority, War Department Standard, Form No. 41 to Field Service. If the supplies were ordered delivered to depots or arsenals Field Service immediately notifies them to that effect and they record the items as dues in. If shipping instructions were not given with the order, Field Service, upon receipt of the copy of Procurement Authority, enters the items on the Consoli-

(Continued on page 470)

Cleveland Meetings of Ordnance District Chiefs and American Society of Mechanical Engineers

THE Spring conference of the Ordnance District organization on industrial preparedness plans and the regular meeting of the American Society of Mechanical Engineers were held in Cleveland on May 26, 27, and 28. The two gatherings comprise one of the most significant preparedness demonstrations of recent years.

The morning meeting of the A. S. M. E. on May 28, 1924, was devoted to a joint session of the Ordnance Department and the Air Service with the Ordnance and Aeronautical divisions of the Society. Papers were presented by Major A. H. Hobley of the Air Service, Lt. Col. A. E. White, Ordnance Reserve Corps, and Capt. E. E. MacMorland of the Ordnance Department. A number of manufacturers from the Cleveland area had been invited to attend and to comment on the papers submitted. In addition, all of the Ordnance District Chiefs took part in the meeting and each briefly set forth his views on industrial mobilization in his district. Further interest was added by a moving picture film presented by Major Hobley of the bombing of the obsolete battleships "Virginia" and "New Jersey" last summer.

At a subsequent meeting of the Society on May 29, Major Earl McFarland, of the Ordnance Department, presented a paper on the interchangeable manufacture of rifle bolts. Since the World War few patriotic meetings to stimulate interest in national defense have been held. The A. S. M. E. in collaboration with various other engineering organizations thought the present an opportune time to renew interest in this vital topic. The result was a preparedness meeting in the Chamber of Commerce hall presided over by Mr. Frank A. Scott, President of the Cleveland Engineering Society, on the evening of May 28 which was attended by about 1,500 engineers and manufacturers. Mr. Bernard M. Baruch of New York, former chairman of the War Industries Board, was one of the speakers of the evening. Mr. Baruch did not deliver his address in person since he had contracted a cold and found it impossible to read the address. Mr. Crowell, President of the Army Ordnance Association, and former Assistant Secretary of War, took his place on the program and read the address for Mr. Baruch. Mr. Baruch's paper was a forceful presentation of his views concerning the necessity for mobilization of the entire resources of the nation in time of war. Among other statements made in the address were the following:

"As a result of my experience with the War Industries Board in 1917 and 1918, I strongly recommend that legislation be put into effect that would give power to the President, in case of war or threatened war, to mobilize immediately, under supervision, the resources of the nation.

"That would mean the mobilization of men, money, materials, manufacturing facilities, and maintenance, the fixing of all prices, regulation and distribution of production.

"This is about what would take place: The military authorities would put into effect a draft of the entire population, from which the required number of men would be drawn, and would place the necessary orders for equipment and material.

"Prices of materials, commodities, and, in fact, all things would be declared fixed as of such and such a date, and it would be illegal either to buy or sell at a different price.

"Money would be mobilized the same as men and materials because a price would be fixed at which money could be used. This would tend to prevent a rise in prices and also would prevent competitive bidding for labor.

"The excess proportion, if any, of the profits in industry and internal revenue would go to the prosecution of the war. Thus you would not only take the profit out of war and make even peacetime profits impossible by increasing all taxes for war purposes, but you would place all the resources of the country at the command of the war-making agencies.

"If such an organization, which we were approaching at the end of the war, had been put into effect at the beginning, the cost of the war, in my opinion, would have been not more than one-half of what it was, and there would not have been charges of profiteering and economic chaos after the war."

Other speakers of the evening were Col. Dwight F. Davis, Assistant Secretary of War, and Maj. Gen. C. C. Williams, Chief of Ordnance, both of whom spoke on various phases of the problem of industrial mobilization for war. The Assistant Secretary forcefully brought home his views, in part, as follows:

"I have come here to speak to you tonight of a special phase of our National Defense which is under my immediate supervision—the problem of industrial preparedness. Let me make one thing clear at the beginning. Our industrial plans are not preparation for war; rather they are insurance against war. A citizen is not seeking to be robbed because he bars his doors and hires a policeman to protect his property; rather, through preparedness, he tries to prevent robbery. A business man is not seeking a fire because he installs a sprinkling system and takes out fire insurance; rather, through preparedness, he tries to prevent fires and lessen the damage. In the same way, a city does not maintain a fire department in order to encourage fires; rather, through preparedness, it tries to prevent them and to stop the destruction as quickly as possible. So in our defense plans, we do not seek war; rather, through preparedness, we try to lessen the destruction and, more important by far, to lessen the probability of war.

"But, it will be objected, how can mere plans lessen

the probability of war? They may do this in at least two ways: If, as many seem to think, munitions makers bring on wars in order to make exorbitant profits, this influence will be eliminated by our plans, because we are firmly determined that hereafter there shall be no profiteering in time of war. But the defense plans will be effective in promoting peace, at least as far as this nation is concerned, in a far more vital way. If it is known that we are prepared in case we are ever attacked to call to our defense every man, every industry, every dollar, every resource, a nation will hesitate long before attacking us. Unpreparedness has never yet averted war; preparedness for self-defense will promote peace. As the Bible says: "When the strong man fully armed guardeth his own court, his goods are in peace."

His strong and patriotic address was closed fittingly when the gauntlet was thrown down before the forces in conflict with reasonable preparedness in these words:

"But there is one class of schemes with which any plan to defend its existence, the territory or the honor of the country is necessarily in conflict. I refer to schemes to disband our defensive forces, to render us helpless and defenseless against invasion from without or revolution from within. These schemes are summed up in the 'Slackers' Oath' which reads as follows:

> "Go to War if you want to, but know this: We have pledged ourselves not to give our children, not to encourage or nurse your soldiers, not to knit a sock, or roll a bandage, or drive a truck, or make a war speech or buy a bond."

"We must choose between the 'Slackers' Oath' and the patriotic advice of Washington, Jefferson, Madison, Lincoln, and Roosevelt; the principles upon which our nation was founded and which have enabled us to develop our ideals of freedom, justice, and liberty. Let us denounce the horrors of war; let us work sincerely, earnestly, patriotically for the preservation of peace; but let us equally, sincerely, earnestly, and patriotically prepare to defend the ideals, the honor, the very existence of America. Let us strive to be an example of international honor, justice, and good-will, worthy of our glorious heritage, ever ready to promote that end we all desire—a universal peace among the nations."

An interesting evening was closed with a showing of selected War Department films demonstrating Ordnance matériel in service, Air Service activities, scenes at the Front in France, and other features. The American Multigraph Company kindly permitted the showing of one of its films showing fuze manufacture during the War which was received with great interest by a critical engineering audience.

The principal object of the conference of the District Chiefs, which was held on the afternoon of May 28, was to discuss the adjustable price contract—the new standard contract form recently completed by the War Department Contracts Board—so that recommendations concerning it could be made to the Assistant Secretary of War.

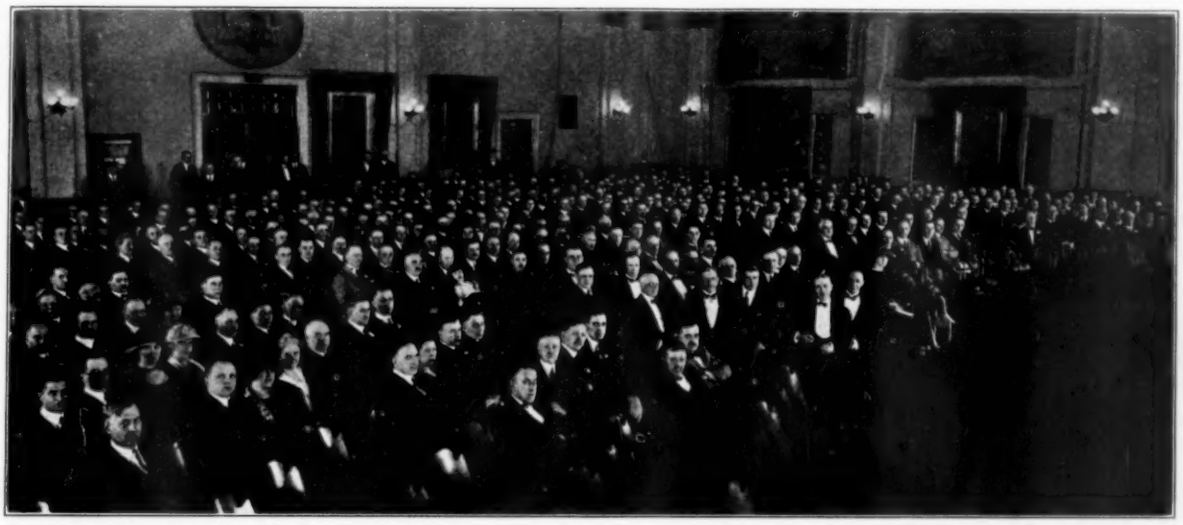


PHOTO: THE MORCHROE CO., CLEVELAND.

A. S. M. E. Preparedness Meeting, Chamber of Commerce Hall, Cleveland, May 28, 1924. Mr. Frank A. Scott, President of the Cleveland Engineering Society, presided.

The meeting was addressed by Hon. Dwight F. Davis, Assistant Secretary of War; Hon. Benedict Crowell, President of the Army Ordnance Association and former Assistant Secretary of War, and Major General C. C. Williams, Chief of Ordnance.

Full and free comment was obtained and a lively debate transpired on some of the provisions. Many obscure points were thoroughly discussed and suggestions were made which will perhaps alter some of the terms of this contract as now written. An interesting feature of the meeting was the presentation by Col. C. H. Tenney, Chief of the Boston District, of an adjustable price war contract which he had actually negotiated and had signed by the Wickwire-Spencer Steel Corporation of that district. Colonel Tenney found that this corporation was willing to sign such a contract contingent on the outbreak of war. He also brought out the fact that there are other firms in that district who are also willing to sign such contracts. In order to reduce the discussion of the problems of contracts in general to specific terms, Gen. C. L'H. Ruggles, who conducted the meeting, furnished fifteen written questions for ballot. Each question was taken up and discussed by the district chiefs with a vote at the end of the discussion.

The district executives met in Cleveland in advance of the district chiefs. Special meetings were held on May 26 and 27, conducted by officers from the Ordnance Office, and dealing with specific details of the district problems. Conferences on ammunition, artillery, contracts, and small arms matters were held.

War Contracts

By

J. G. BOOTON

BEFORE and up to the period of the late war, whatever effort toward standardization of contracts and contract clauses there may have been was on a purely informal basis. That is, if a particular clause used in the contract of one of the procuring services was found to be either particularly good or particularly bad, information as to this was obtained informally by other procurement branches and acted on according to their needs. Certain clauses in various contracts thus became similar.

World War Experiences

At the beginning of the war, there arose a need for forms new to the War Department, such as the cost plus contract, and the cost plus with an estimated cost and a provision for sharing any saving. These new requirements, together with the appointment of officers from civil life to positions in the contract sections of the procuring agencies of the War Department, and the variety of conditions under which the various contractors wished to work for the United States, resulted in a great variety of contracts. During 1918 effort was made to standardize the contracts in some particulars and certain articles were prescribed by the War Department for use in all contracts. This has been continued and the present Ordnance contracts contain certain mandatory and certain optional clauses, worded as prescribed by the War Department.

During the period of settlement of war contracts, it was manifest that while many contracts were good, some were doubtful and others were open invitations to trouble both in performance and during settlement, and that none were by any means as good as they could be. Various conferences were held at which suggestions were offered and as a result some improvement in form was obtained. These improvements were directed generally toward peace contracts, with the intention, of course, that such improvements would persist in time of war. It became apparent, however, that a contract or series of contracts for peace-time procurement could never meet the needs of an emergency. Therefore, on October 10, 1921, a board was appointed consisting of an officer from each of the procuring services of the War Department and with a member from the office of the Assistant Secretary of War to act as recorder, for the specific purpose of standardizing the form of war contracts.

Interdepartmental Board of Contracts and Adjustments

At about the same time the Bureau of the Budget issued Circular No. 47 establishing in the Office of the Chief Coordinator, a board to be known as the Interdepartmental Board of Contracts and Adjustments, the members and functions of which Board were to be as follows:

Each executive department to organize a departmental board made up of one representative of each bureau having the independent right to enter into contracts, which board was to recommend policies to control in the standardization of contracts within such department. The chairman of the several department boards and the Chief Coordinator to constitute the Interdepartmental Board of Contracts and Adjustments.

The functions of the Board were:

First, to standardize the forms and methods of contract-letting wherever possible to the end that a uniform policy on the part of the Government should control the making of such contracts, and with further view to such changes in form as would tend to enlist the interest of the contractor on behalf of economy and promptness of execution, and *eliminate the uncertainties of construction and hazards* to be assumed by the contractor which have operated to increase the cost of Government work and supplies.

Second, to recommend general policies in the settlement of outstanding obligations arising out of contracts of the United States, such as methods of determining and enforcing damages, of settling disputes as to questions of fact, and of determining the final compensation of contractors.

Third, in an advisory capacity and when requested by the head of any department or establishment, or his representative upon the Board:

(a) To review and revise important contracts and agreements made or about to be made on behalf of the United States;

(b) To advise officers authorized to contract and operating under contract as to the proper interpretation of contracts in process of execution;

(c) To assist in the negotiation of important contracts and agreements relating to personal services, supplies, or contruction work.

As the work of the War Department Board under this order was collateral with that of the board to standardize war contracts, the War Department on December 9, 1921, in constituting the "War Department Board of Contracts and Adjustments" appointed in most cases the same officers as were on the Board to standardize war contracts.

Model Contracts

The War Department Board of Contracts and Adjustments proceeded to make a study of all existing forms in the War Department used for procurement purposes with a view to reducing a total of a hundred or more to the least number that would properly serve the various purposes and services. It has prepared a model contract for each purpose for submission to the Interdepartmental Board, as did many of the other departments. The War Department drafts were selected as models and upon them have been built a form for government lease of privately owned property, which has been adopted as a standard government form, and a form for construction contracts, which has been tentatively adopted and returned to the various departments for comment. The comment of the War Department Board has been completed and returned to the Interdepartmental Board.

Work is progressing on the form for a procurement contract, but it is not so far advanced. There is also in

course of preparation a manual for contracting officers.

Securing a departure by the many interested agencies from practices and policies of procurement long current is naturally a slow process. It is principally one of mutual education and exchange of ideas and information which has been helpful to all departments, even if it should not result in a common form of contract for each of the various purposes.

Another activity of the Board has been the compilation of laws under which the various agencies of the government procure and an effort to weed out the obsolete ones and to combine those still of value into a uniform code composed of the best and most efficient and to apply them, in so far as can be done, uniformly to all procuring agencies. Such a result is of course far in the future, if it can ever be accomplished. As in the case of contracts, it has resulted in a study of the procurement methods and policies of other departments and has brought to light many inconsistencies in the laws governing different departments and establishments, which may result in the gradual improvement of all the laws.

Finality of Review

Another matter to which much consideration has been given, is that of the finality of payments and adjustments. As the situation now is, a contractor has no assurance that a settlement made with one agency may not be reviewed by several others. Since the war this practice of review has grown to such an extent that in many cases it has become virtually blackmail under the guise of "protecting the interests of the United States." When the amounts involved are comparatively small and the contractor is faced by a threat of suit in which he will, of course, be alleged to be a profiteer, he will in most cases waive his rights and compromise on the best terms he can obtain. The frequency and persistence of these reviews and demands for restitution have driven many good contractors, capable of rendering excellent service to the United States, to the point of refusing all government work. It has forced those who still do business with the government to retain attorneys, skilled in and familiar with all the vagaries of government methods—or lack of method in doing business—to guard them against the many ways in which they might suffer losses by failing to comply with the strict letter of the hundreds of laws, regulations and decisions which may affect their contracts. Worst of all, it necessitates the addition of a percentage to their costs to cover possible vagaries in the interpretation of their contracts or in passing on their performance. This percentage, together with the cost of all the reviewing agencies now being supported by the government, which justify their existence by their recoveries or promised recoveries, accounts for much of the high cost of doing government business. Upon the matter of administration of contracts, Attorney General Wickersham, in a letter to the President on December 22, 1909, said: "I am unable to concur in the view that executive officers are limited in matters of this kind wholly to considerations affecting the pecuniary interest of the Government. In my opinion the honor of the nation is of greater importance. As stated by Judge Taney when Attorney General, there is nothing in the nature of our institutions which requires officers of the government to perpetrate an act of injustice in the name of the United States. On the contrary, I think the principles of morality underlying our republican form of government are such as to make it the duty of executive officers, so far as possible, to avoid working wrong or injustice to the people. In the present case it is manifest that the enforcement of the contract in question would simply cause a wrong which Congress would have to be called upon to right. Such enforcement would, therefore, expose the Government to merited reproach." Those who are familiar with some of the principles and policies proposed with reference to our contracts in the last three or four years, and with the action taken thereunder, can judge as to how meticulously the government is following this opinion. The probability of a hostile and critical review of any administrative settlement, now serves to prevent the various procurement agencies of the government from doing business upon an honest and honorable basis. This situation has been given much consideration by the various members of the Board of Contracts and Adjustments, with a view to its improvement.

The general trend of desire and suggestion seems to be for a strong Board composed of representatives of the heads of each of the Government departments, to act as a board of appeal and review upon questions of contract interpretation and payments. This Board should be composed of members familiar with the practical problems of procurement and should be in a sufficiently strong position to resist demands for suits and claims against contractors upon inequitable technicalities. The power of this Board would serve as a protection to government officers at the site of the work by assuring them that just and equitable decisions would have a just, equitable and final review, should they ever be questioned.

When the proposed system is organized and working it should serve to relieve the contractors from the probability of "Safety First" decisions by contracting officers, because under present practice the contracting officer knows that any other kind is subject to a technical review and that any possible waiver of a technical point that he might use to "protect the interest of the United States" may result in endless trouble to himself and to the contractor.

It will also relieve the present situation as to appeal from decisions of the officer at the site of the work. The contractor has theoretically the right to appeal to the head of a bureau and from him to the head of a department. The actual situation, is, however, that such right of appeal is of doubtful value. Upon appeal to the head of a bureau, that head considers the record and ability of the officer at the site of the work and if his prior record is good the head of the bureau is naturally inclined to support him even if he cannot see clearly the equity of the decision. The same is true of an appeal to the head of a department. In each case the contractor must meet and overcome the natural tendency of each chief to support his organization, so in strong organizations he must overcome a very heavy handicap before he can reach the actual question of the justice of a decision. An independent Board whose only self interest would be that their own departments should be protected in the doing of justice, would serve to relieve this situation of the contractor, and the fact that such a reviewing board existed would exert a great influence with officers at the site of the work to do actual and not the minimum of technical justice to the contractor. The action of such a board would be prompt, inexpensive and generally known, and would soon serve to establish a definite and well considered policy for the transaction of government business. It would serve to relieve the Court of Claims of many cases where arbitrary action has been taken by the government, and to relieve many cases where the amount is too small to take to the Court of Claims. The general idea of such a Board has not yet crystallized to the point of definite and positive recommendation, but the need of some such organization, which, due to its position and lack of self interest, shall be as nearly as possible investigation-and-review-proof is

strongly felt, if the United States is to depart from its present objectionable practices and enter the market as a desirable customer.

As to the specific question of war contracts there have been proposed and discussed five general forms:

The first is a form for purchase orders. This has been simplified and shortened to require the minimum of typing and to contain only essential directions and instructions to the contractor. It has been approved for war use and suggested to the various procuring agencies of the War Department for peace time use as soon as it can be conveniently adopted.

Fixed Price Contracts Adjustable for Wages and Materials

The second is a form for fixed price contracts, adjustable for changes in wages and for changes in prices of material. A contract of this type has been completed, submitted to the Secretary of War, studied by the office of the Judge Advocate General and returned to the Board with his comments.

The salient features of this contract are:

(a) Limitation of liability on account of subcontracts to finished work and to such part of the costs of materials, work or parts on hand at suspension as pertained to the uncompleted portion of the sub-contract.

(b) A list of property and any changes in the plant which the contractor proposes to amortize, to be filed within sixty days from the date of execution of the contract, such list, when approved by the contracting officer to become the basis for settlement of claims in the event of termination.

(c) A schedule of wages upon which the contract price is based, which would be the basis of an adjustment of the contract price in the event of justifiable changes.

(d) Payments to be made on estimates of the percentage of completion of the work.

(e) Payment in case of termination for—

1. Completed articles.

2. Expenditures on account of uncompleted portion, including material, labor, unamortized portion of increased facilities, unamortized portion or rehabilitation costs, and cost of settling subcontracts, and salaries of administrative overhead for thirty days after termination.

3. In case termination is abrupt and creates an industrial crisis, two-thirds of straight rates of pay to employees actually engaged on the work at termination and separated from their employment by reason of the termination, to be paid for forty-five days.

4. Interests on any amounts payable on account of termination that are not paid within sixty days of termination.

5. Provision for taking over U. S. property by the contractor at the prevailing market price.

The other features follow in general the usual contract forms. This form has, however, been held in abeyance to consider an entirely new method of procurement proposed by Mr. E. F. Cassel.

"Probable Cost" Basis

This method requires a consideration of the elements of probable cost in order to negotiate a contract. Under the first general division of "Preparatory Costs" is included:

1. Plant preparation.
2. Additional tools (initial equipment only).
3. Additional facilities (purchase price less fair value).
4. Cost of installing government-furnished facilities and of dismantling and shipping them on completion.
5. Preparatory production cost.
6. Special fees, for engineers or other special or technical services not available in contractor's organization.

For each of these the contractor submits his estimate, supported in the case of increased facilities by a tabulated list showing purchase price and fair value to him of principal items.

Under the next general division of "Production Costs" are:

1. Cost of direct labor, administrative and operating overhead.
2. Cost of miscellaneous labor, with applicable administrative and operating overhead.
3. Cost of component parts secured by purchase or subcontract.
4. Royalties on patents not owned by contractor.

The last general item is "Rehabilitation costs."

To the whole is added the contractors "Profit."

By requiring the submission of estimates in this manner the negotiating officer is fully informed as to what the government will actually receive for its contract price. He can place his contracts so as to make the best use of existing facilities and to provide new ones only when an actual shortage exists. He can compare various estimates for similar articles and the information he acquires should enable him to place his orders to the greatest advantage of all concerned.

As to the work involved for the contractor, nothing is required that he should not consider if he is to make an intelligent bid for the work. It should in fact serve to prevent a contractor from making a pure guess on the cost of the work with what he thinks is an ample margin for contingencies and profit, which guess may be far too small or far too large. It is desired to point out that a contractor who seriously underestimates his costs on a war contract and is awarded a fixed price contract on such a basis will in most cases get the government into as much trouble as he gets himself. It is neither economical nor efficient to place such contracts, and the government should use as much care in seeing that the contractor can actually produce under the terms and conditions of his contract as it does in seeing that his price is not too high. The government goes to great pains to feed and clothe and house its soldiers so that their health and strength may be preserved. It is equally dependent on its contractors who produce war materials and can not afford to have their efficiency reduced by improvident contracts. As Justice McKenna so aptly says in the Supreme Court decision U. S. vs. Purcell Envelope Company, March 31, 1919: "And it is not out of place to say that the government should be animated by a justice as anxious to consider the rights of the bidder as to insist upon its own."

It may seem unusual to set out and pay as they are incurred, the incidental costs for plant changes, special tooling, increased facilities, etc. These costs are usually concealed in the unit price of articles and are not discovered unless the contract is cancelled. They are, however, in the price that the government pays, so might better be considered and analyzed prior to drawing the contract which agrees to make the payment.

The method proposed includes payment to the contractor of his costs as they are incurred. This is for the purpose of financing him upon a reasonable and definite basis. The method of payment upon estimates of completion included in the former fixed price contract is believed to be too uncertain in its operation when operated by inexperienced personnel. The method of payment of costs as incurred, provides a definite means and procedure by

which the contract is financed, and is much less liable to failure in the hands of overcautious or overzealous officers. Should the contract be cancelled, settlement of most items will have already been made and the amounts still to be paid will be comparatively small.

It will be noted that in case of cancellation, the contract is settled on a cost plus basis, limited, however, by the estimate for each item. This is, of course, open to the objection that a contractor who may have taken a contract which would net him a considerable loss were it completed, would not suffer a proportional loss if his contract were cancelled. It is believed, however, that the assurance of payment on a cost basis in the event of cancellation is a sound policy and will in general result in a much greater saving on completed contracts than will be the possible loss on those that are cancelled.

The Government a Good Customer?

The effort has been to produce a contract which will assure a contractor that he can work for the government on a fair basis, that will assure him a prompt and fair settlement whether the contract is completed or cancelled and that will keep his company in healthy condition during performance of the contract.

This was not true of the contracts let in the last war. A great many contractors, due to their war efforts, converted a sound and healthy company free from debt and paying dividends into a heavily obligated one with expanded facilities for which no use could be found and with no prospect of paying dividends for a number of years to come.

It may be mentioned that the war claims of the entire War Department were settled for 13.24 per cent of the cancelled portion of the contracts. The percentage for Ordnance contracts was 13.11. Considering the vast amount of special facilities and special materials and articles on hand, this is a good indication that many contractors suffered actual loss. Many are known to have received less than fifty cents on the dollar of their expenditures on war contracts. These contracts are now being reinvestigated and demands made and suits instituted for particular items of payment or settlement. The result is that contractors generally look upon government contracts, whether in peace or war, as extremely unsatisfactory if not actually hazardous business. I am gratified to say, however, that they are generally satisfied with the efforts of the Ordnance Department to do justice and seem generally satisfied that the Department has understood their difficulties and has done the best it can under existing restrictions of law, regulations and opinions to settle fairly and justly.

Sub-Contracts

There are two principles which are now being discussed by the board on war contracts which merit attention. The first is that under which sub-contracts are to be handled. After much discussion and study it has been decided to divide sub-contracts and orders into three classes.

The first, is for standard materials or articles of trade or manufacture. These may be issued without reference to the contracting officer, but the liability of the government in the event of cancellation is limited to articles delivered or in transit at the time of cancellation of the prime contract.

The second, is for articles of special materials or design. This class can be let with the approval of the contracting officer so as to obligate the government for materials on hand and work in process in the sub-contractor's plant pertaining to the uncompleted portion of the sub-contract, but is not to include increased facilities or other preparatory costs or rehabilitation of the sub-contractor's plant.

The third, let with the specific consent of the contracting officer and with his approval as to the actual terms is for cases where the sub-contractor is required to produce an entirely different product from his normal one, where he must absorb plant changes, new tooling, increased facilities and rehabilitation costs. In such cases the sub-contract may be let on a basis similar to that of the prime contract. The government is not, however, to be obligated in any case for any commitments of the sub-contractors. This will cause the prime contractor to make all purchases where commitments are involved and it is believed will cause a closer supervision and control of sub-contractors than if each sub-contractor could make commitments and the sub-sub-contractor could in turn make commitments, all of which the government must consider and must settle in case of cancellation.

Date on Which Contract Becomes Effective

The second principle is that of the date on which a contract becomes effective. This is particularly important in case of contracts placed before the emergency. It has been seriously proposed that a contractor be allowed to put in from time to time certain of the facilities, tools, etc., needed for his war production, that the expenditures so made be reported to the District Offices, and, if approved, become an item of reimbursement if the contract becomes effective due to an emergency. This is an interesting suggestion and would undoubtedly serve to interest and encourage contractors in their preparation for war contracts. There is, however, a question as to whether the administrative work involved would be prohibitive and whether it would not create trouble in the event of improvements in war materials which would render a contractor's purchases worthless. It has been argued, however, that the position of the contractor would be no different than that of a reserve or national guard officer who has spent time and effort on some branch of warfare that may become obsolete.

Considering the possible difficulties, the Board has adopted the principle that expenditures should not be reimbursed except when made after the contract is put into effect. The great difficulty with this is that it does not provide for the efforts and expenditures of a contractor made when war is imminent but an emergency has not been declared. In this case the contractor should have every encouragement to prepare for his contract with the assurance that if an emergency was declared he would be fully reimbursed for his efforts. If the war cloud passed on, he could not well be paid, except by the knowledge that his effort toward preparedness had undoubtedly been of effect in avoiding it. I think most contractors would proceed on this basis. Such an arrangement would do much toward advancing the date of delivery of munitions and is worthy of serious consideration as a policy. The allied question, which is more of a technical one, is the method of covering expenditures made prior to the actual signing of a contract negotiated and executed after war begins. Our contracts have been dated back to the date of the "go ahead" order to the contractor. This tends to create some questions which can be avoided by dating each document as of the date of its actual preparation and execution. While negotiating the details of a proposal and contract, some work will be started by the contractor. In order that he may be reimbursed for this promptly on execution of the contract it is proposed that he submit a schedule of such expenditures together with the date of actually beginning work and that these be approved by

the contracting officer and incorporated in the contract as authority for their reimbursement. This, as before stated, is only a minor detail. I would, however, urge the consideration of a policy as to encouraging contractors to make preparations for performing the contracts assigned to them in time of peace. It will be particularly valuable, should war appear to be imminent, for the contractor to be able to make such preparation as the situation appears to justify with full assurance that he will be treated at least as well as if he had made the same preparation after war had actually begun. It will be necessary that such expenditures be definitely protected in the degree and amount to which they are desired, otherwise they are extremely liable to be ruled out as expenditures made by the contractor in his own interest.

It is not proposed to pay for this preparation unless and until the emergency of war comes. If there is any lesson that has been taught the United States by our Civil War and our World War, it is that time is the most important element in warfare; and delays run into billions of dollars and thousands of lives. With reasonable encouragement, there is no reason to doubt that all contractors will make some preparation and it is self-evident that, in case of war, this preparation will be invaluable to the Government. It will permit contractors to get into production months in advance and the Government will repay, instead of war costs of this preparation, the peace cost to the contractor. The encouragement of the contractors to do this work, the supervision and administration, can now be efficiently performed for a negligible amount.

The above contract is a fixed price contract, despite the provision for reimbursement as expenditures are made. The fixed price is for the entire contract and not a unit price for articles. The fixed price is, however, adjustable for change in costs of labor and costs of materials from a schedule filed with the proposal. The general provisions of the contract to carry into effect the principles of the proposal are now completed.

Two other forms of contract have been written and comments requested. They are a cost contract for construction, and a cost contract for manufactured articles with a fixed profit and a division between the contractor and the government on a percentage basis of savings under the estimated cost.

Comments and criticisms have been solicited and obtained upon these as a basis for further revision. A "War Department Definition of Costs" applying to all of these is in process of preparation.

It will probably be necessary to add a simpler form of fixed price contract which will be secured by adding to the Standard Supply Contract suitable clauses covering cancellation, guards, espionage and priority. Consideration of this form is awaiting the adoption of the Standard Supply Contract by the Interdepartmental Board.

Status of Work

The work has been interesting and instructive and while it may appear to have gone slowly it has been necessarily so because it has been a process of accumulation and development of ideas and experiences which cannot be forced too much if they are to be fully developed.

The adjustable price contract has been completed and will soon be ready to try out on contracts for war production to be placed in time of peace. Some valuable suggestions may be expected when this is done. It is believed, however, that the most likely contingencies have been met in a manner fair to the contractor and to the government and that the contract will form a sounder and better basis for procurement in time of war than we have ever had before.

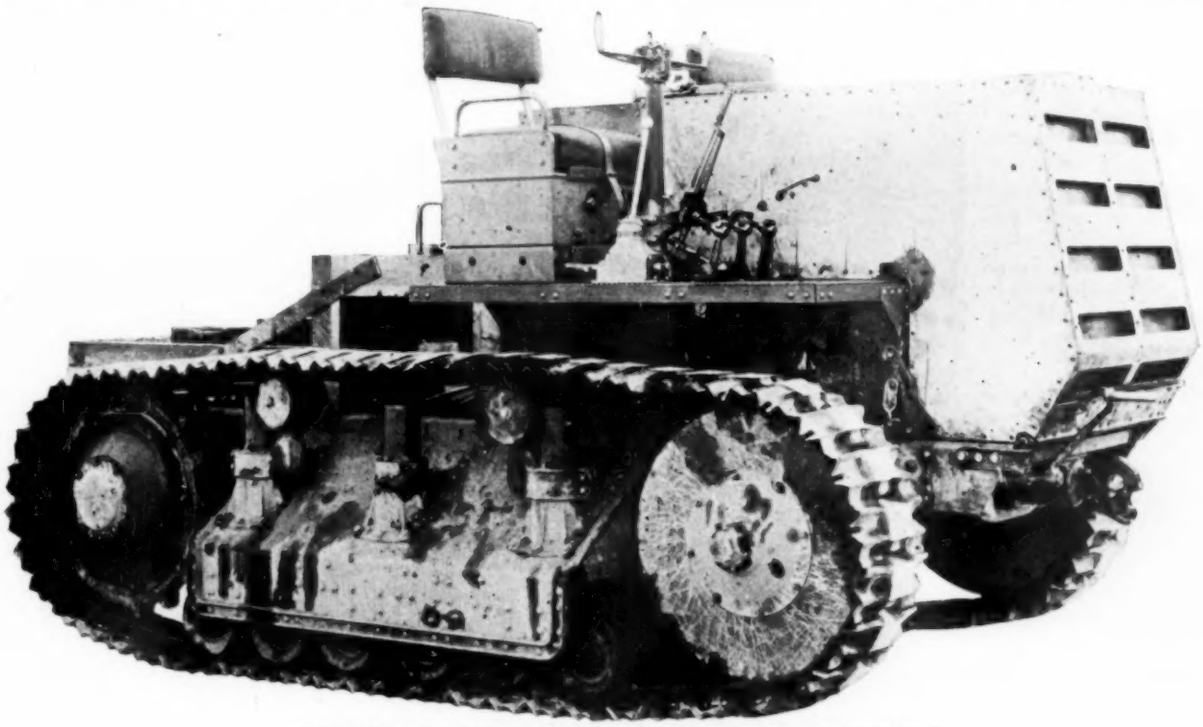
Since the completion of this form of contract there has arisen a question as to whether any form of "cost contract" for manufactured articles is necessary or desirable. It has been urged on the one hand that the feature of financing the contractor, together with the adjustment of the contract price for changes in the cost of labor and material, will allow of reasonable bids for work for which specifications are complete. It has been argued, on the other hand, that there will be many cases where no contractor will feel warranted in making a bid that is reasonably near what the work should cost, because it has never been done in quantity before and because of the risk of delays in transportation of materials, possibility that the design may not be suitable for quantity production and other extra expenses that may occur in producing a new article under war conditions. Under such conditions it has been proposed to use a form of contract in which the contractor is paid a fixed fee based on the value of his plant and equipment used for the work, the value of the part of his organization that will be employed and the time the work should occupy plant and organization. The work would be done at the cost and risk of the Government, but to give the contractor a material incentive for efficiency in its performance there would be set an "estimated cost" for the work based upon the best experience and estimate obtainable, with a provision for rewarding the contractor in the event he could make a saving. One proposed method is to give the contractor one-fourth the percentage of saving times the actual cost as an addition to his fixed profit. This will give a very material reward for introduction of more efficient methods of manufacture, from which he can promise substantial bonus to his employees in the event they are able to do the work for less than the estimated cost. This should serve to secure to the Government the most rapid and efficient production possible. There is some difference of opinion as to whether there should be any penalty for exceeding the estimate. The principal argument in its favor is that some classes of contractors would not hesitate to run up costs to their possible benefit toward the end of a contract if it became apparent that they could not complete for less than the estimated cost. The actual value of such a feature would depend on the number of contractors of doubtful honesty with whom the Government must place contracts. As for the Ordnance Department the cases in which it might be of value will in all probability be negligible, and the possibility that a contractor, in spite of his best efforts might lose part of the fixed fee that he must have to continue in business would tend to raise both the fixed fee and the estimated cost of all contracts placed on this basis.

As a further general objection to the adoption of this form of contract, it has been urged that contractors will know of its existence and will insist on having a contract of this form unless their margin for possible losses is ample. The answer would appear to be that if a contractor is seeking such a form of contract as a concession the negotiator for the Government would be in excellent position to secure the lowest fixed profit on which the contractor could operate and the lowest estimated cost that he could be expected to reach.

It is believed that generally the sum of the fixed profit and the estimated cost will be very materially lower than the price that can be obtained under the "Adjustable Price Contract" and that generally contractors will be able to do the work for enough less than the estimate to amount to a further considerable gain to the Government.

The New Corps Tractor

THE experimental Corps Tractor, recently delivered to the Aberdeen Proving Ground for test, was designed and built in an effort to meet the requirements of the Caliber Board in a tractor for the Corps Artillery load. It was originally intended that this tractor should be of the convertible type, that is, that it be capable of operating on round wheels on good roads at comparatively high speed, and be readily converted into a track-laying vehicle for cross-country service. Pending the development of a satisfactory type of removable flexible track and running gear, the Corps Tractor, as completed, is essentially a track-laying vehicle, using a conventional type of track, but having a suspension somewhat different from that used on the conventional track-laying vehicle.



The Latest Corps Tractor Developed by the Army Ordnance Department

As produced, the experimental tractor is not convertible in the field, but in the process of manufacture it can be readily completed as a wheeled tractor-truck or as a track-laying tractor by leaving off the bogie frames and using wheels with tires of sufficient capacity for the load, or by including the bogie frames and replacing the round wheels with track idler and driving sprocket the vehicle is readily made into a track-laying machine.

The present tractor is essentially an experimental vehicle on which several types of tracks will be tried out in an effort to produce a satisfactory type of track of the convertible type. The same frames, transmission, power plant and steering arrangement are used, regardless of whether the vehicle is operated on round wheels or on tracks. The arrangement of the units parallels very closely the arrangement of units in a motor truck.

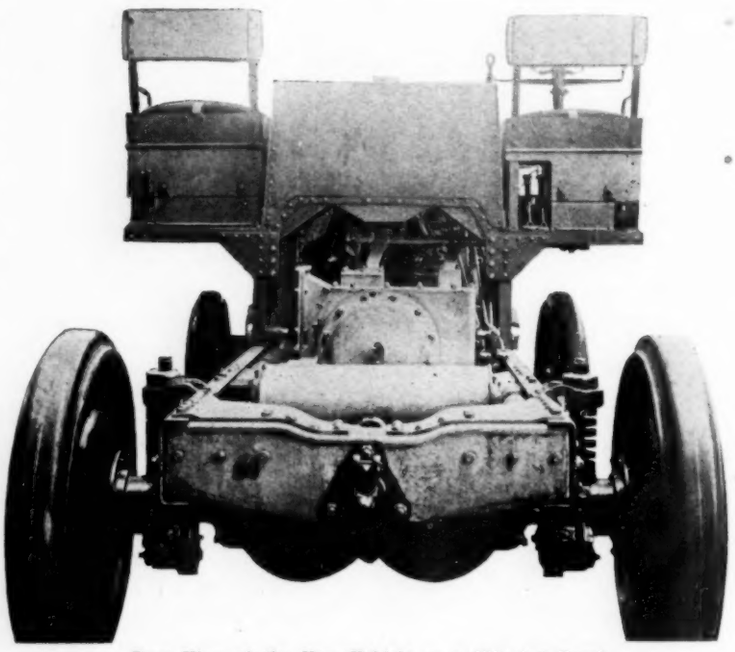
The frame is of the structural built-up type, with heavy pressed steel side and cross members. It is made of chrome-vanadium steel, and throughout is the finest type of construction. Considering the general design, it is not intended that this should be a rigid type of vehicle, but should have the greatest amount of flexibility throughout the mounting of all the units, and, therefore, it is intended that there should be a certain amount of weaving of the frame itself.

The rear axle is mounted along lines paralleling the mounting of rear axles for truck use. The suspension springs under the frame, however, are of the helical type in place of the usual leaf springs, making necessary the use of torque arms. The axle proper may be termed a dual type of drive, having separate drives to each wheel or sprocket, this type being necessary to answer the requirements of a track-laying vehicle. There is a double reduction in the drive to the track sprocket, one a bevel gear reduction is at the center of the axle, and the other a spur gear reduction in the track sprocket. The spur gear reduction in the hub of the sprocket consists of a spur pinion on the end of the axle shaft which meshes with two intermediate pinions on fixed axles spaced opposite each other; the intermediate pinions mesh with the ring gear of the sprocket.

Both the motor and the transmission, which is mounted amidships, are of the three-point suspension, and every

precaution has been taken through all the units to mount them so that they are independent units, receiving and transmitting their own individual stresses and not receiving the strains or stresses from any adjacent part due to unusual weaving of the frame or other unusual displacements.

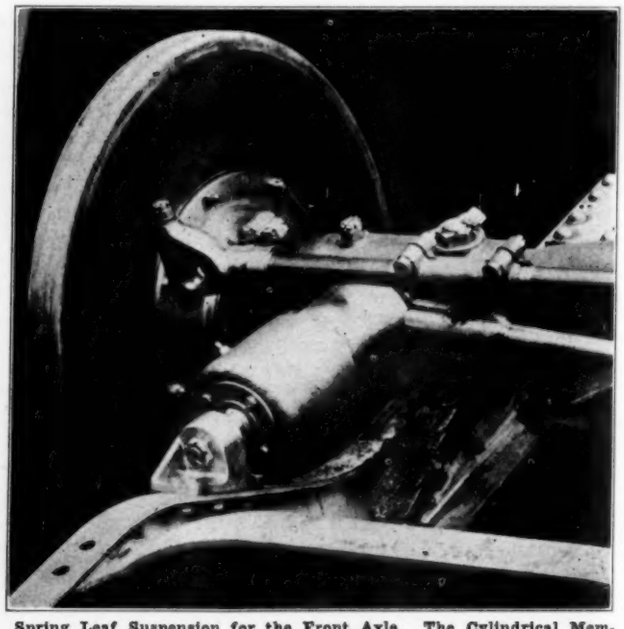
The front axle is of the tubular type and is also mounted along lines paralleling truck mounting, having leaf springs in place of helical springs as used in the rear. This front axle, in addition to the leaf spring suspension, has a helical spring mounted directly back of it at either side and adjacent to the frame member, which is intended to give backward flexibility in case of loading of the tracks when operating as a track-laying vehicle. This helical spring is fully inclosed so as to protect it and give a neat appearance to the mounting. The wheels at either end of the axle are mounted on steering knuckles, the center of the steering knuckle being on the center line of the wheel. The steering knuckles are provided with a locking mechanism for use with a track.



Rear View of the New Vehicle as a Wheeled Truck

Note the Coil Spring Suspension for the Rear Axle and the Torque Arms Necessary for this Type of Spring

The suspension of this vehicle, considered as a track-layer, is made to give the minimum amount of unsprung weight. Practically the only parts that could be considered unsprung would be the 70 inches of track on the ground, and the three bogies and their vertical pilots on each side. As will be noted from the illustrations, the bogies, which consist of two rollers in a set and three sets to a side, are spring-mounted inside the bogie frame, and the bogie frame is bolted directly to the main frame. The helical springs are extremely long and, therefore, give an extreme amount of flexibility, the movement of the spring being five inches. The bogies, therefore, have a total movement of five inches, giving a satisfactory amount of flexibility for operating over rough terrain. The truck wheels and the bogies have what is termed "rubber cores" in their centers, with steel tread. This gives a small amount of additional flexibility and reduces the amount of noise of the wheels when running over the linked track. The track supporting rollers have a rubber tread to lessen the noise at this point.



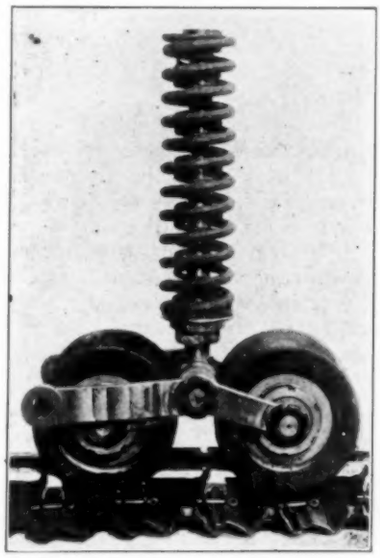
Spring Leaf Suspension for the Front Axle. The Cylindrical Members Under the Frame House the Track Release Springs for Use With the Track

The engine is a commercial 4-cylinder marine type, having 5¾-inch bore and 6¾-inch stroke. It is a 16-valve, valve-head type, with removable heads. The displacement is 701 cubic inches, and the engine develops 108 brake horsepower under actual test at 1,200 r. p. m.

The transmission unit is of an unusual design in that in the unit there are combined a dual transmission and a dual shift. The first, or auxiliary shift, consists of two speeds forward and one reverse. The second, or primary shift, consists of three speeds. Therefore, there are in this transmission six speeds forward and three speeds reverse. Secondly, there are combined in the transmission and inclosed within the same unit, in a dry compartment, the main clutch, or master clutch, and two steering clutches. These are mounted in such a manner that one or all can be easily removed from the rear end of the transmission without disturbing any other unit.

This vehicle is designed to take a cargo body. The approximate size of this body would be 84 inches wide, 90 inches long and 2 feet deep, and would have a capacity of from 3 to 5 tons. In view of the fact that this vehicle is to be used as a cargo carrier and a tractor adds to the problem of suspension. This problem relates to the question of getting extreme flexibility and yet have the vehicle ride on a normal keel whether loaded or empty, or whether pulling under a maximum draw-bar pull, or with no trailed load. It can be seen that putting a cargo on a vehicle of this class changes the center of gravity of the complete job, and changing the position

of the center of gravity changes the normal keel on which the vehicle rides. It may either cause it to ride low in the rear or low in the front, depending on how the suspension springs are adjusted. Also, either pulling the load or with no trailed load has the same general effect. Therefore, in the design of a vehicle of this class, some study will be required to first design it so that applying



Bogie Construction and Spring Mounting for the New Corps Tractor

a cargo does not shift the center of gravity. This proposition is not impossible. And, secondly, in place of having the reaction of the draw bar 28 inches from the ground, it should come at the ground. This is an impossible proposition, and, therefore, it is a problem of either allowing the tractor when pulling under heavy load to ride low at the rear, or to stiffen up the suspension sufficiently to make this feature not objectionable.

In order to allow the space given above for cargo, the operator has been placed at the front over the right-hand tracks and at the side of the motor. An additional seat is provided at the opposite side of the motor, over the tracks.

The curves show the general maximum performance of the vehicle under assumptions which are given with the curves. In addition to the general performance of the vehicle for the six speeds, there is also shown a curve of maximum performance with 100 per cent traction. This shows that this maximum possible performance with 100 per cent traction is practically obtained at the second speed, and at low speed the maximum is exceeded, and that, therefore, this vehicle will slip its track under all conditions on low speed, and under a large number of conditions at second speed. These curves are made up with the vehicle equipped as a tractor and show that at the sixth speed it will not operate as a tractor except under most favorable conditions and with no trailing load. However, the sixth speed was put in not for use as a tractor, but for use as a wheeled vehicle.

The table of general characteristics following are the specifications as a track-laying vehicle. As a wheeled vehicle, with some additional study in connection with features necessary when opertaing as a truck, it can be made to serve satisfactorily as a truck-tractor or for use in connection with semi-trailer operation. As a wheeled vehicle it is equipped with solid tires. The speeds as a wheeled vehicle are about 16 per cent higher than the speeds as a tractor. The weight as a wheeled vehicle, complete with gas and oil, is 11,475 pounds.

General Specifications as a Track-laying Vehicle

Overall length, 179 inches.

Overall width, 87 inches.

Height, 89.5 inches.

Length of ground contact, 66 inches.

Ground clearance, 14 inches.

Weight, complete with gas and oil, 16,200 pounds.

Ground pressure, per square inch, 8.2 pounds.

Weight of each track, 1,100 pounds.

Weight of each track shoe, complete with grouser, 25 pounds.

Width of track shoes, 15 inches.

Tread of tracks (center to center), 68 inches.

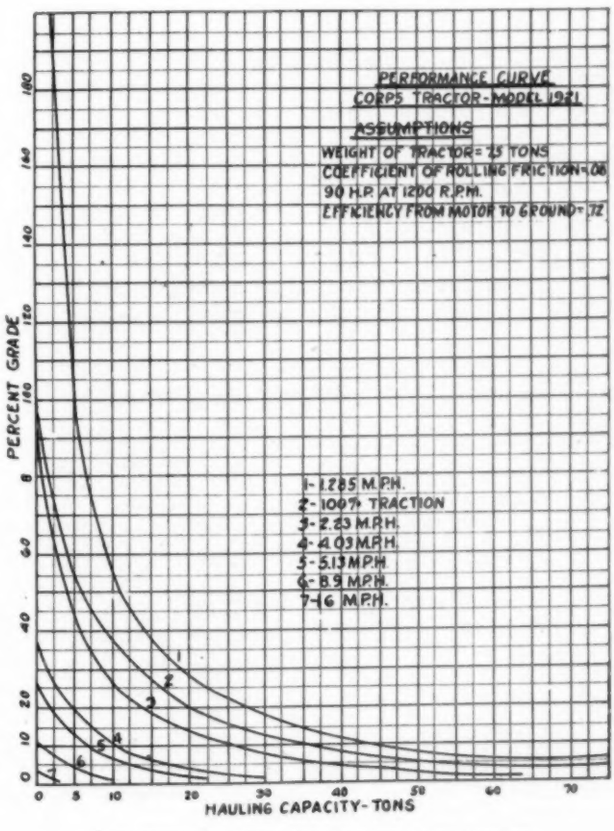
Diameter of turning circle, 140 inches.

Road speeds at 1,200 r. p. m. of motor: Low speed, 1.285 miles per hour; second speed, 2.23 miles per hour; third speed, 4.03 miles per hour; 4th speed, 5.13 miles per hour; fifth speed, 8.9 miles per hour; sixth speed, 16.1 miles per hour. Reverse: Same as first three forward speeds.

Capacity of gasoline tank, 53 gallons.

Capacity of oil tank, 6 gallons.

Brake horsepower at 1,200 r. p. m., 108.



Performance Curve for the New Corps Tractor

The Elements of Firing Table Construction

By

H. S. BECKMAN

THE sources of information for all final firing tables issued by the Ordnance Department are the range firings conducted at the Proving Ground for that specific purpose. In view of the fact that great importance is attached to such firings and that additional information such as is not required in other firings is of primary importance in the preparation of firing tables, care is taken that such information as is necessary should be obtained with great accuracy and precision. The gun chosen for the purpose is usually one that has been fired but few rounds and whose life will not be at an end before the firing program is completed.

When the gun is placed in a position to fire the angle which the trunnion axis or carriage axle makes with a level line is determined by means of a transit and level rod. This angle is known as the cant. The rod is placed upon either the trunnions or the hub caps of the wheels of the carriage. The distance between the points at which levels are taken is also measured. This is done several times during the firing. The azimuth of the line of fire is then ascertained. To insure that the gun does not deviate from the given line of fire from round to round at a given elevation, a bore-sighting stake is placed a short distance in front of the gun and in the line of fire. By sighting on this stake the proof officer is able to determine at each round whether he should traverse the gun in order to get on the established line of fire. The height of trunnions above mean low water is determined by obtaining the height of the trunnions above known monuments, whose elevation above mean low water has been definitely established. The tide is obtained at various times of the day by readings on the tide gauges. Since the area in which range firings are conducted has been mapped and a co-ordinate system worked out, in order to obtain the range and deflection of a shot it is necessary to know not only the co-ordinates of the point of fall, but also those of the gun. The co-ordinates of the gun are ascertained from the known co-ordinates of monuments as established on previous occasions. In order to insure the accuracy of the range and deflection of a shot the co-ordinates of each point of fall are obtained by means of intersecting azimuths from at least four observation towers.

Of primary importance are the characteristics of the projectile fired and the fuze with which the projectile is armed. The mark of a projectile and weight alone do not usually distinguish it. Thus an 8-inch H. E. Shell, Mark I, may have either a lipped band, machined band, a groove in back of the hump of the band, either in the steel of the shell or in the band itself. Also it may have a straight base or it may be boattailed. The two projectiles shown in Fig. 1 below illustrate the importance of noting the characteristics of the projectile. The difference in range between them as obtained from range firing is about 3,000 meters, at about 40° and the dispersion is also vastly different.

The days on which the firings are conducted are those on which the visibility is good and wind fairly small. During the time of firing the Signal Corps Station at the Proving Ground observes the direction and velocity of the wind at various altitudes either by the use of two theodolites or one, observing on a 6-inch or 9-inch balloon. In case one theodolite is used the rate of ascent of the balloons has been established to be as indicated below:

26-inch balloon (Inflated)	36-inch balloon (Inflated)
1st minute 240 yds.	300 yds.
2nd minute 220 yds.	275 yds.
3rd minute 220 yds.	275 yds.
4th minute 210 yds.	270 yds.
5th minute 210 yds.	255 yds.
200 yds. for every minute thereafter	250 yds. for every minute thereafter

The pressure, temperature, and humidity at the surface are recorded by the Signal Corps for various times of the day. This enables the computation of surface density for any given instant. Once or twice during the day on which range firings are conducted the Air Service makes temperature flights during which temperatures at various altitudes are recorded. By means of the known pressure at the ground the pressure at various altitudes is computed. With this information and the known temperatures at those altitudes, the corresponding air densities are determined. The densities aloft for times other than the time of the temperature flight are obtained on the assumption that the densities at altitudes above 1,500 or 2,900 meters remain constant during the day. Accordingly the surface

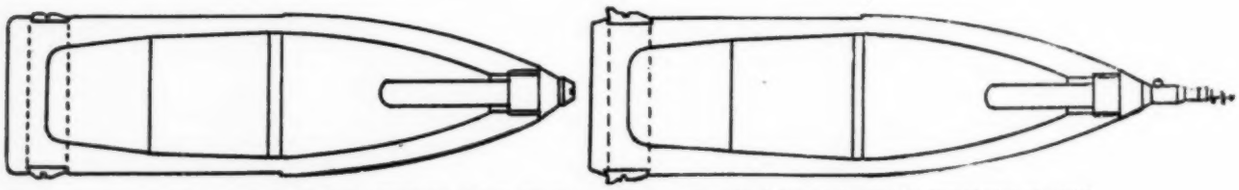


Fig. 1. 8-inch High Explosive Shell, Mark I, Straight Base Model at left; Boattailed Model at right

density *at the time of firing* is plotted as a point on the density chart for the time of the airplane flight. From this known point a curve is drawn which is made to converge gradually with the density curve as established by the temperature flight, thus obtaining the densities aloft up to 1,500 or 2,000 meters. The temperatures aloft at the

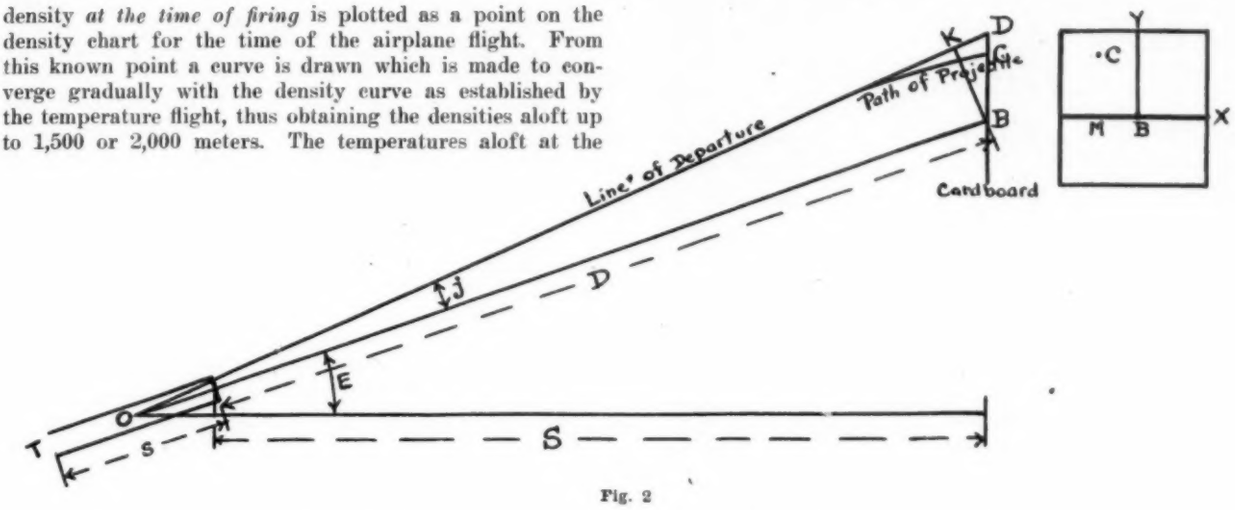


Fig. 2

time of firing are obtained from the known temperature at the ground at that time and the temperatures obtained during the airplane flight on the basis of a similar assumption to the one employed in obtaining densities aloft at the time of firing, namely, that above a certain altitude the temperatures remain constant from hour to hour.

Velocity Rounds

The firing on a given day is begun by the firing of a warming shot, which is usually a slug. The so-called "velocity rounds" are then fired, for which velocities are measured in addition to the other necessary quantities. Range rounds then follow, for which similar data is recorded as for the other shots, except that the velocities are not measured. At the end of the day, in many instances, velocity rounds are again fired. The velocities are obtained by the use of the Boulenge, Solenoid, or Aberdeen Chronographs which measure the time that elapsed between the passage of the projectile through two screens which are at a known distance apart. Thus the velocity at the mid-point is obtained by the relation, $\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$.

This velocity is corrected back to the muzzle by the so-called *Z* curves which can be utilized after one knows the distance from the muzzle of the gun to the mid-point of the straight line joining the centers of the two screens, and the so-called ballistic coefficient which has been established for various forms of projectiles. In cases where the powder is known to be erratic or where the gun is rapidly wearing and is therefore losing velocity, it has been the policy to take velocities on all range rounds if possible.

The seating of the projectile is also measured on all rounds in a range firing program where fixed ammunition is not used. The velocities for rounds in which no chronographs have been used are estimated on the basis of the seating and weight of projectiles for those rounds in comparison with the seating and weight of projectiles for which velocities have actually been measured. The relations employed are

$$\frac{dV}{V} = B\frac{dS}{S}$$

$$\frac{dV}{V} = N\frac{dp}{p}$$

Where dV, is the change in velocity;

V, is the mean of the velocities observed on the velocity rounds;

dS, is the difference between the mean seatings observed on the velocity rounds and those where no velocities were measured;

S, is the mean of the seatings measured on the velocity rounds;

dp, is the difference between the mean weights of the projectiles as determined on the velocity rounds and those on which velocities are being estimated;

p, is the mean of the weight of the projectiles obtained on the velocity rounds.

The values of B and N are negative and have been obtained experimentally and theoretically for various guns and projectiles. The powder charge, of course, remains constant as well as the temperature of powder. The procedure outlined above is followed only in cases where the guns do not wear rapidly. In cases where the guns lose their efficiency quickly the velocity drop between successive groups of velocity rounds is also taken into account.

Measuring Jump

The jump which is defined by the equation "Jump equals Quadrant Angle of Departure minus Quadrant Elevation," is usually measured on the velocity rounds. In the velocity screens, cardboards are inserted which have marked upon them a boresighting point. This point is the intersection of two heavy lines, one vertical and one horizontal, forming the X and Y axes. The gun is then aimed at the point of boresight. By measuring the distance from the boresight point to the center of the hole formed by the projectile on passing through the cardboard, and knowing the distances to the cardboard, one is enabled to compute the vertical and lateral jumps. To illustrate:

In Fig. 2 let E be the angle of elevation; j, the angle of jump; S the horizontal distance from muzzle to cardboard; s, the distance from trunnion axis to muzzle. During the small interval of time it took the projectile to get to the cardboard, the path of the projectile has deviated from the line of deparature by the distance CD, as shown on the diagram. This distance, the drop due to gravity,

equals $\frac{1}{2} gt^2$, where $t=\frac{D}{V}$ and D=S sec E (approximately). The distance BC, as stated above, is measured

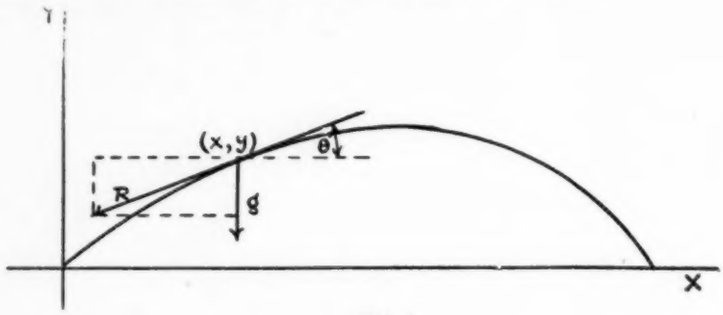


Fig. 3

on the cardboard, plus if above the X axis and minus if below. The linear jump then at the known distance from O is given by the expression BD=BC+CD. The pivot of jump has been empirically ascertained to be about half way between the trunnions and the muzzle. To obtain the angular jump, j, draw BK perpendicular to OD, so that

$$\text{angle DBK}=E+j$$

$$BK=BD\cos(E+j)$$

$$\text{and}\quad \sin j=\frac{BD\cos(E+j)}{D+\frac{s}{2}}$$

Since j is small, the above equation can be written j (minutes) =

$$3438\frac{BD\cos E}{D+\frac{s}{2}}$$

The lateral jump is computed from the knowledge of the distance MB as measured on the jump screen.

Thus, in Fig. 4,

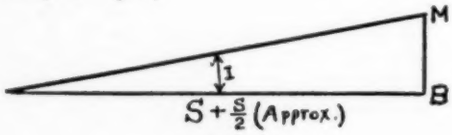


Fig. 3

$$\tan I=\frac{MB}{S+\frac{s}{2}}\text{(very nearly)}$$

Since I is small, the above equation can be written

$$I\text{ (minutes)}=3438\frac{MB}{S+\frac{s}{2}}$$

The range firing record as issued by the Ordnance Department contains the following information obtained as outlined above:

The date and time of firing,
The projectile lot, weight and other characteristics,
The weight, lot, and temperature of powder,
Pressure,
Muzzle velocity,
Barometer, thermometer and humidity,
The magnitude and direction of the surface wind,
Azimuth of line of fire,
The quadrant or clinometer elevation,
The observed range and deflection,
Jump.
In addition, other information such as the proof officer considers important is recorded.

The elevation of the gun is obtained with a quadrant placed on the jacket of the gun over the chamber. The parallelism of the top of the jacket or other quadrant rest and the axis of the bore of the gun is checked by comparing the readings of a clinometer placed in the muzzle with the quadrant readings. The quadrant used is also calibrated.

Correction of Observed Ranges

The first step in the construction of a firing table consists in correcting the observed ranges, approximately, to standard conditions by utilizing the data contained on the firing record and also the data obtained from the Signal

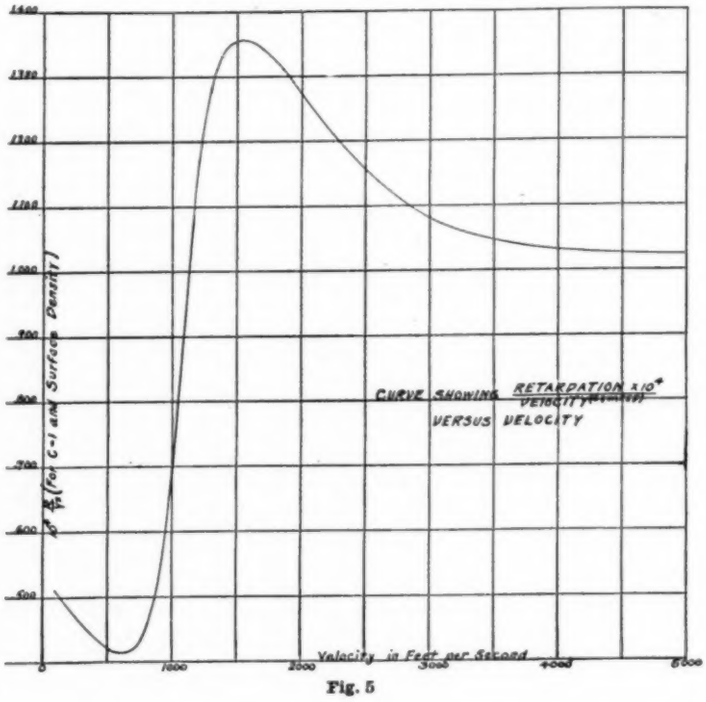


Fig. 5

Corps during the time of firing. Later the observed ranges and deflections, as is explained below, are corrected with great accuracy to standard conditions. The standard conditions assumed throughout range table computations are:

Wind, none,

The density is standard. The standard air density law will be discussed later.

The temperature of the air is standard. The standard temperature law will be given later.

Muzzle velocity, as predetermined, for which the table is to be computed.

The weight of projectile as predetermined for which the table is to be computed.

The gun and target are at the same altitude above sea level.

The earth is motionless. This is of importance only in the case of long range guns.

Since it is the angle of departure, and not the angle of elevation, which controls the shape of the trajectory, or path of the projectile, the angle of elevation must be corrected for jump in order to obtain the angle of departure. In its final form, however, the firing table gives the angle of elevation for each range, and not the angle of departure.

Computation of Trajectory

After the observed ranges are approximately corrected, the next step consists in the computation of a number of trajectories at different elevations and at the various zone velocities. By the computation of a trajectory is meant the determination of the horizontal and vertical coordinates and the corresponding velocity components at comparatively short time intervals throughout the flight of the projectile. This is accomplished by solving the differential equations of motion by the process known as numerical integration or mechanical quadrature. In Fig. 3, R denotes the retardation due to resistance of the air which acts along the tangent to the trajectory, so that

(1) $R_x = -R\cos\theta$

(2) $R_y = -R\sin\theta - g$

where, R_x is the retardation in the X direction

R_y is the retardation in the Y direction

[The action of gravity is assumed uniform in intensity and is independent of the geographical location of the gun, $g = 9.80 m/s^2$]

The law of air resistance used in this country at present is that formulated by the Gavre Commission of France, for velocities up to 648 m/s; from 648 m/s to 1200 m/s the table from Charbonnier's *Traite de Balistique Exterieure* is used and from 1200 m/s to 1800 m/s the air resistance law has been extrapolated scientifically. The air resistance curve, or rather the curve of $\frac{R}{V^2}$, is given in Fig. 5. Note that the law is formulated for standard surface air density, a certain temperature of air, and a projectile of certain characteristics whose ballistic coefficient is 1 (one).

Let us denote the retardation due to air resistance for standard surface air density and for a projectile of unit ballistic coefficient by R_1. For standard density at any other altitude it has been assumed that the air resistance will be proportional to the ratio of the standard density at that altitude to the standard surface density, this ratio being denoted b $H(y)$. It is obvious that some projectiles are better and others poorer than the one for which the standard retardation law has been established, whose ballistic coefficient is unity. The ballistic coefficient is often defined as the ability of the projectile to penetrate the air; that is, a projectile whose ballistic coefficient is 3 encounters only 1/3 the resistance of a projectile whose ballistic coefficient is 1. R therefore may be expressed as follows:

$$(3)\quad R = \frac{R_1 H(y)}{C}$$

Substituting (3) in (1) and (2) we get

$$(4)\quad R_x = -\frac{R_1 H(y)}{C}\cos\theta$$

$$(5)\quad R_y = -\frac{R_1 H(y)}{C}\sin\theta - g$$

Instead of using R_1 directly the Ordnance Department makes use of another function known as

$$(6)\quad G(v) = \frac{R_1}{v}$$

Substituting (6) in (4) and (5) we obtain

$$(7)\quad R_x = -\frac{G(v)\ H(y)}{C}v\cos\theta$$

$$(8)\quad R_y = -\frac{G(v)\ H(y)}{C}v\sin\theta - g$$

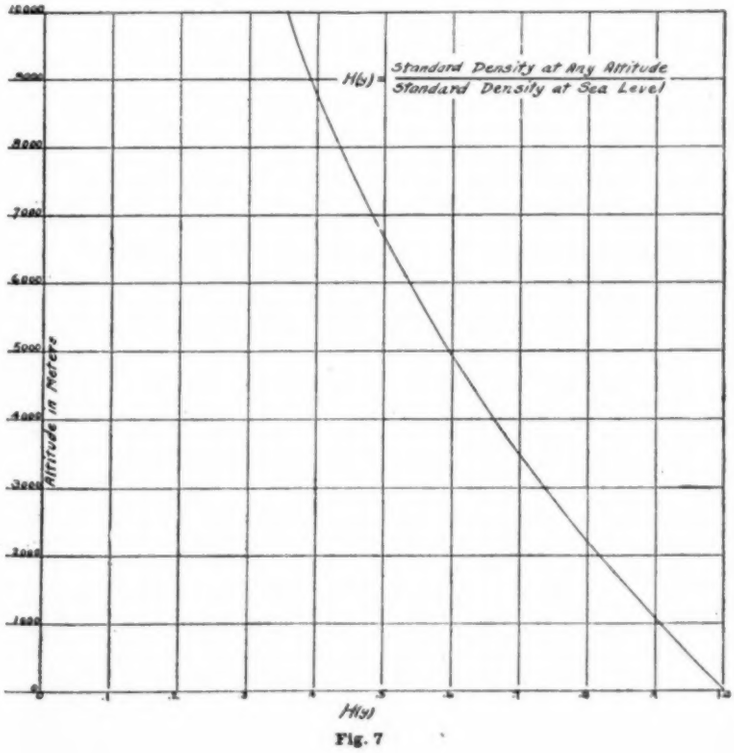


Fig. 7

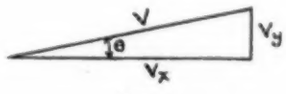


Fig. 6

But from the diagram (Fig. 6) it is seen that $v\cos\theta = V_x$, the velocity in the X direc-

tion, and $v \sin \theta = V_y$, the velocity in the Y direction so that the final equations of motion are

$$(9)\quad R_x = -\frac{G(v)\ H(y)}{C} V_x$$

$$(10)\quad R_y = -\frac{G(v)\ H(y)}{C} V_y - g$$

These equations, as was stated above, are solved by numerical integration, which requires simple numerical computations for certain intervals of time along the trajectory. This method of computing trajectories is due to Lt. Col. F. R. Moulton.

However, the accuracy of any method depends not only on the mathematical theory and the mode of solution of the equations but also on the knowledge of the air resistance encountered by a projectile during its flight. Whether the ratio of the retardation experienced by projectiles of different shapes is independent of the velocity is at least doubtful, although in the absence of adequate data it has been assumed that such is the case. Experiments are now being conducted under the direction of the Ordnance Department to determine the resistances encountered by various types of projectiles.

The ballistic coefficient in numerical integration is defined by the formula $C = \frac{w}{id^2}$, where w is the weight of projectile in lbs., d, the caliber in inches and i the so-called form factor or coefficient of ignorance. Formulas have been proposed to give the value of i in terms of the radius of the ogival head. Such formulas are of doubtful validity as it has been conclusively demonstrated that by boattailing the projectile, considerable variations in range are obtained.

The ratio of the standard air density at any altitude to the standard density at the ground, or gun, denoted by $H(y)$, has been established in this country as equal to $10-.000045\,y$ where y is the altitude in meters above the ground or gun. It is customary to use the sea level as a reference plane. The standard density at sea level has been assumed, after careful study of meteorological data, to be 1.2034 kg/m³ so that the density at any altitude can be expressed by the relation D kg/m³ $= 1.2034 \times 10 - .000045\,y$. See Fig. 7.

This law is satisfactory up to about 9500 m, but because of its theoretical advantages has been assumed to hold for altitudes above 9500 m.

The standard temperatures at various altitudes for ballistic purposes is shown in Fig. 8.

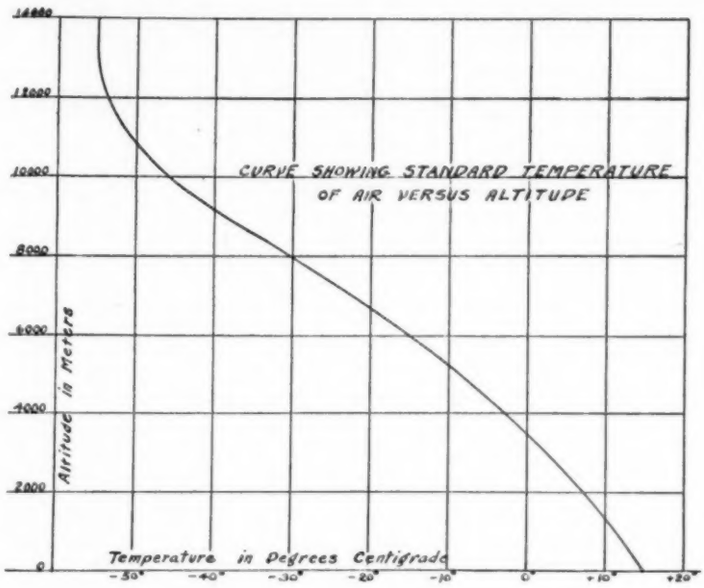


Fig. 8

Corrections

The next step is to compute, corresponding to each of the trajectories, the variations in range due to deviations in the conditions of firing from those assumed for the computation of trajectories. These variations are computed for a double purpose; first, for correcting the results of the firings to standard conditions and second for insertion in the range table for use in the field. Certain minor adjustments to these variations are occasionally necessary.

The only correction that may be obtained directly from the trajectory is that for the difference in the levels of gun and water or, in case of shrapnel firing, for the difference in the levels of gun and burst. In case the difference in levels is small and the elevation fairly large the range correction may be taken to be the difference in altitude multiplied by the cotangent of the angle of fall.

It is apparent that the correction for velocity could be computel by comparing the ranges of two trajectories accurately computed in which the angles of departure and ballistic coefficient are the same, while the velocity is different. The change in range for a given change in elevation could be computed by noting the difference in range between two trajectories computed for the same velocity, same ballistic coefficient and somewhat different angles of departure. The range correction for a certain *percentage* change in density, the same all along the trajectory, could be obtained by comparing ranges obtained from two trajectories in which the angle of departure and velocity are the same while the ballistic coefficients are different. It is to be noted from equations (9) and (10) that a percentage *increase* in air density has the same effect on the equations of motion as the same percentage *decrease* in the ballistic coefficient. The only case, where, according to present available data, it seems legitimate to assume that variations occurred in the air resistance law, is that arising from the effect of a change in temperature on the velocity of sound. From Fig. 5 it may be noted that the air resistance around the velocity of sound changes by leaps and bounds. It is well known that an increase in temperature increases the velocity of sound. It is therefore reasonable to assume, since the big hump in the curve is due to the velocity of sound, that this hump and the entire curve would be moved to the right for an increase in temperature above the standard, and to the left for a decrease in temperature below standard. Thus air resistance curves could be worked up for various surface temperatures. By computing two trajectories in which the initial conditions are the same and the $G(v)$ functions different and noting the difference in range one could obtain the so-called temperature (elasticity) correction for a given change in temperature. The effect of wind on range may be computed from the knowledge of the time of flight, change in range for a given change in angle of departure and change in

range for a given change in muzzle velocity by the theoretically accurate formula given in standard text books on ballistics

$$\Delta R_{wx} = W_x \left(T + \frac{\sin \Phi}{V} \Delta R_\Phi - \cos \Phi \Delta R_v\right)$$

where

ΔR_{wx}, is the range effect of the ballistic range wind
W_x, is the ballistic range wind
T, the time of flight
Φ, the angle of departure
V, the muzzle velocity

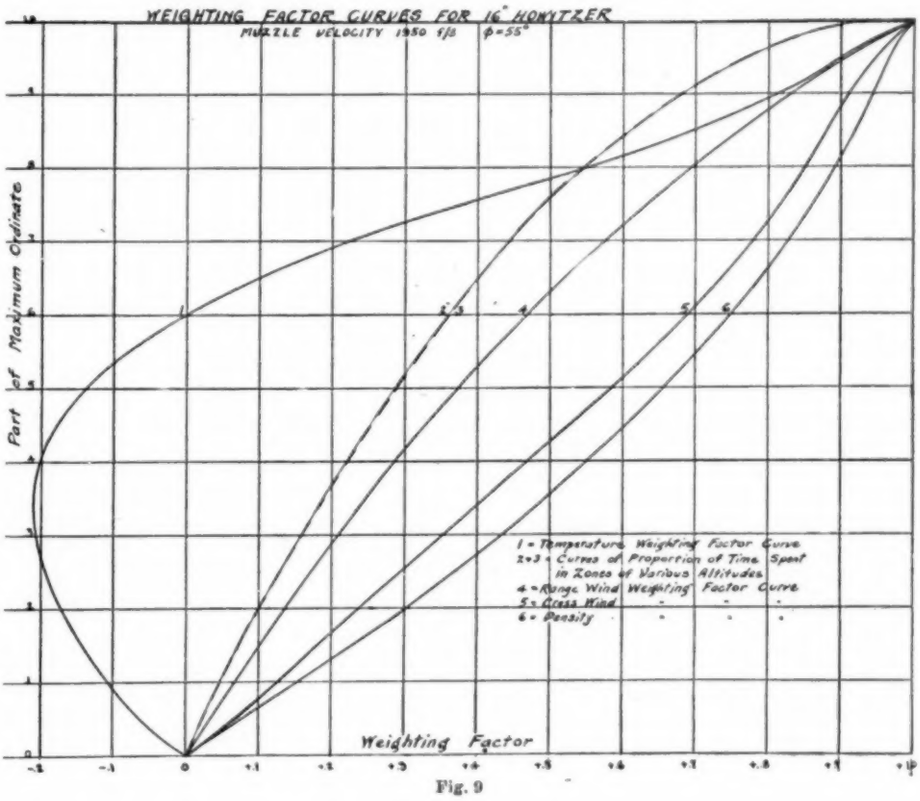

WEIGHTING FACTOR CURVES FOR 16" HOWITZER
MUZZLE VELOCITY 1950 f/s Φ=55°
Part of Maximum Ordinate
1 = Temperature Weighting Factor Curve
2+3 = Curves of Proportion of Time Spent in Zones of Various Altitudes
4 = Range Wind Weighting Factor Curve
5 = Cross Wind " " "
6 = Density " " "
Weighting Factor

Fig. 9

$\Delta R\Phi$, the change in range for unit change in angle of departure

ΔR_v, the change in range for unit change in muzzle velocity.

The results given by this formula have been checked recently at the Proving Ground by firing almost simultaneously and over about the same area two guns, whose azimuths of fire differed by 180°. The results, which are considered very reliable, since all sorts of precautions were taken, indicated that the formula was very accurate. In fact, there was only a difference of about 6 per cent between the observed and computed values. This test also enabled the checking of the effect of cross wind on deflection as obtained by the formula

$$\Delta D_{w_y} = W_y \quad T - \frac{R}{V \cos \Phi}$$

where

ΔD_{wy}, is the deflection effect of the ballistic cross wind;
W_y, is the ballistic cross wind;
R, the range.

The results in this case showed that there was a difference of only 2 per cent between the observed and computed values of the cross wind effects.

The effect of the rotation of the earth could also be obtained by computing trajectories, one by the old method, equations (9) and (10), and another in which those equations have been altered to take account of the rotation of the earth. The effect of rotation of earth becomes appreciable in long range guns and only in those cases is it taken into account.

Most of the methods outlined above for computing corrections and effects for variations from standard conditions were mentioned merely for academic interest. Due to the mathematical ability of Moulton, Bliss, and Gronwall a method of obtaining those effects has been devised which simplifies the work considerably. These methods are described in detail in various Technical Staff, Ordnance Department, and War Department publications. From the computation of one of those so called "differential corrections," which is carried out step by step at small time intervals, one can obtain the effect for any deviation from standard in any altitude zone.

Atmospheric Computations

The computation of the effects which involve atmospheric data is carried out for certain constant values. Thus the effect of a 1 m/s wind at all altitudes and in the line of fire, the effect of a 1 m/s wind at all altitudes and perpendicular to the line of fire, the effect for a one per cent change in air density all along the trajectory, and the effect of a one per cent change in absolute temperature at all altitudes, are computed. Such constant deviations are of course only theoretically possible. In practice, conditions similar to those above are very rarely met. Thus winds may be favorable to the flight of the projectile and blowing to the right in certain altitude zones, while in other zones the reverse will be true. The density may be below normal during part of the flight of the projectile and above normal at other points. Similar comment will hold for temperature. This is mentioned merely to point out the futility of correcting for surface conditions only.

The question now arises, since winds, densities and temperatures vary from altitude to altitude on given days according to no particular law, what is the "average" wind, density, and temperature over a trajectory? Shall we give equal weight to the deviation in all zones from standard conditions? The answer is, NO! As was mentioned above the computation of a differential correction permits of ascertaining the effect in each altitude zone.

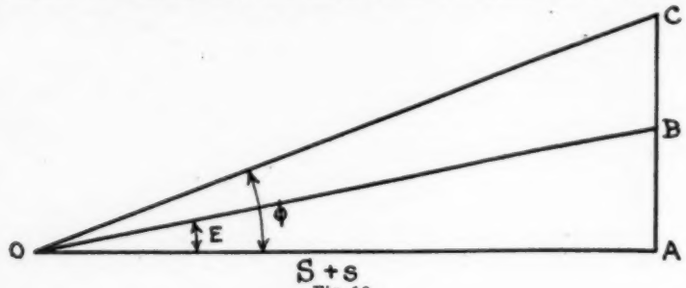


Fig. 10

This effect in each zone is compared with the total effect over the entire trajectory and percentages are thus arrived at, which form the basis of the so called "weighting factor" curves. Some are shown in Fig. 9.

The curve marked 2, shows the relative times spent in each zone as computed from a trajectory. That marked 3, is an approximate curve based on assumptions occasionally used; namely, that the time spent by the projectile in the zone bounded by the surface of the earth and an altitude equal to one fourth of the maximum ordinate is 0.13 of the total time of flight; in the second quarter 0.16; in the 3rd quarter 0.20; the fourth quarter 0.51 of the total time of flight. Note how closely these curves coincide, and the extent to which they deviate from the others shown.

Fig. 11

If in the case cited above we divide the trajectory into ten zones, each equal to one tenth of the maximum ordinate the weighting factors read for each zone in succession from the ground up are in the case of range wind .07, .07, .07, .08, .09, .09, .10, .12, .14, and .17. These when multiplied by the range wind in each zone and added together give the ballistic range wind. Similarly for density, cross wind, and temperature.

Determination of Accurate Winds

After the trajectories, differential corrections, and weighting factor curves have been computed, the next step is to work up the *accurate* ballistic range wind, cross wind, density, and temperature. The winds in each altitude zone are resolved into two components, one in the line of fire and the other across the line of fire. These when multiplied by their respective weighting factors and added together yield the ballistic range wind and ballistic cross wind. The density for each altitude is compared with the standard density; the ratio of observed density to standard density for each zone is given its respective weight, and the sum of the products giving the ballistic density. The deviations in observed temperatures from standard at various altitudes are expressed as a percentage of the absolute temperature and these percentages are weighted by the factors obtained from the temperature weighring factor curve.

In connection with wind the question has often arisen whether the wind obtained at the gun is the same as the wind which would be obtained at some distant point along the trajectory. In this connection a program was carried out in which winds were recorded at the Proving Ground, and at Swan Point, a place some 20 miles away. Ballistic winds obtained from observations aloft at both places varied little.

On the basis of the effects computed for given deviations and the ballistic data obtained for the time of firing, the observed ranges are corrected now accurately and not approximately to standard conditions enumerated above. To the ranges thus corrected, for a given V and θ, there corresponds a certain ballistic coefficient. The latter can be obtained from a comparison of the corrected range with the trajectory range, computed for that elevation and velocity, with an allowance for the effect on range of a per cent change in C (density) as obtained from the differential correction. The C's obtained for various elevations are plotted and a smooth C vs θ curve drawn which best represents the plotted points. This curve forms the basis for computing the range elevation relation. The maximum ordinate, time of flight, angle of fall, terminal velocity, and difference in range for difference in levels of gun and target are obtained from the trajectories computed. The various range effects are obtained from the differential corrections. Both the data obtained from the trajectories and that obtained from differential corrections may be slightly corrected because the C's used for their computation may be slightly different from the C's chosen for the computation of the range table.

Range Correction for Weight of Projectile.

The range correction due to variation in weight of projectile requires some consideration. As was stated above, the velocities are either measured or estimated, in general upon the consideration of the weight of projectile and its seating. An increase in weight, therefore, affects only the ballistic coefficient which, as was indicated above, varies directly as the weight. Thus a certain percentage change in weight increases the ballistic coefficient by the same percentage, and the change in range due to that percentage change in ballistic coefficient can be computed from the effect of density on range already ascertained from the "differential corrections." In the field, however, no velocities are observed. Since the velocities were originally established for a given charge and projectile weight, it is reasonable to assume that, if the weight of the charge is the same and the weight of projectile different, this change in weight will change both the velocity and the ballistic coefficient. The change in velocity is given

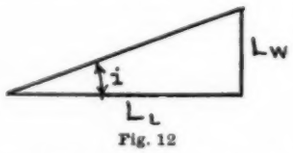


Fig. 12

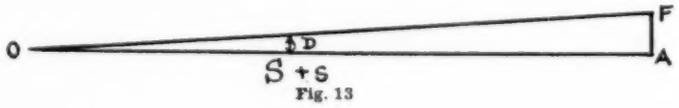


Fig. 13

by the relation $\frac{dV}{V} = N\frac{dp}{p}$; the ballistic coefficient is changed

by the same percentage as the weight. Both changes were discussed above under certain topics. The algebraic sum of the effects due to change in velocity and ballistic coefficient is the so called field weight correction.

To obtain the deflection due to drift the observed deflections are corrected for cross wind and cant and in the case of long range guns for the rotation of the earth. The effects due to cross wind and rotation of the earth are obtained, as was stated above, from the "differential corrections." The effect of cant is obtained in the following way.

Let E be the angle at which the gun is boresighted; ϕ, the angle to which the gun is elevated for firing; s,

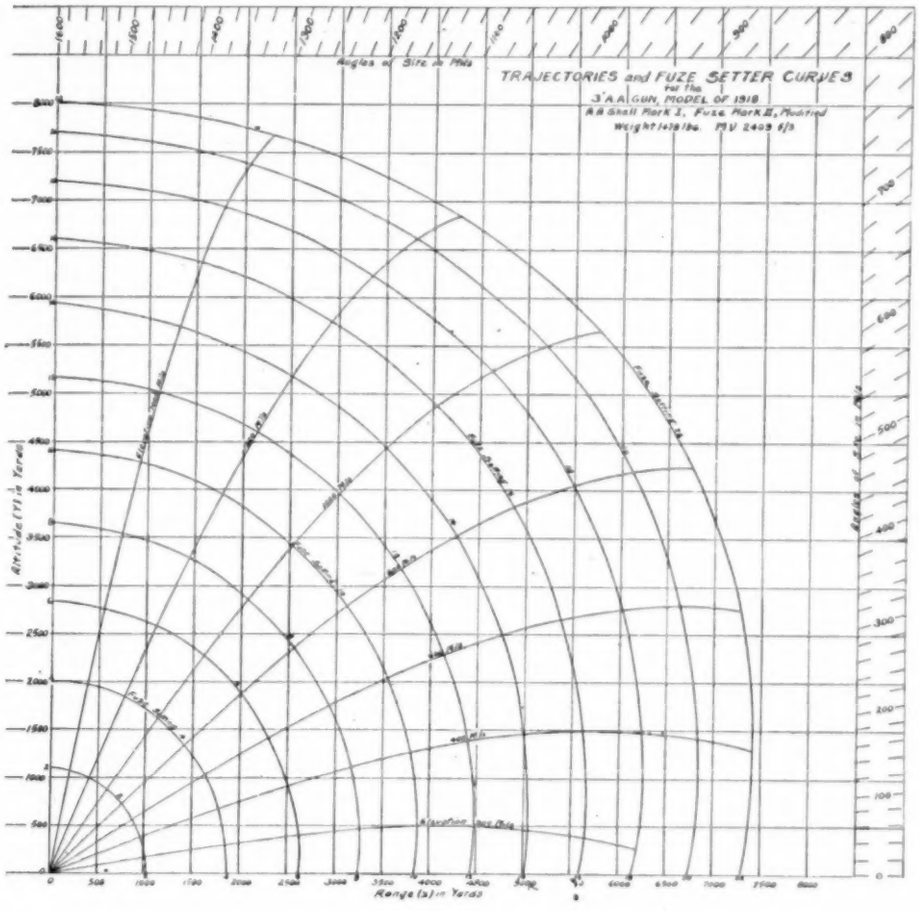


Fig. 13

the distance from the trunnions to the muzzle and S the distance from muzzle to screen at which the gun is boresighted. If the trunnions are level the line of boresight will travel vertically up the screen from B to C, a distance equal to

$$(S+s)\ (\tan \phi - \tan E)$$

But this line will be tilted an angle i, if the trunnions are tilted an angle i by having one of the trunnions above the other, where i is the angle of cant whose tangent is the distance one wheel is above the other divided by the distance between the points where levels were taken, $\frac{L_w}{L_1}$. The tilted line will now cut the screen at C^1, a distance

$$(S+s)\ (\tan \phi - \tan E)\ \sin i$$

from the vertical line passing through the original boresighting point and the deflection of the point from the line of fire will be

$$\tan D = \sin i\ (\tan \phi - \tan E).$$

The deflection due to drift includes the effect of lateral jump. In the case of guns designed with trunnion axis not level with respect to the carriage axle the effect on deflection of this "permanent cant" is also included in the drift.

Shrapnel Fire.

In shrapnel fire the time of flight is also observed and is compared with the fuze setting for graze burst at various elevations, thus yielding a sort of ratio curve between the two quantities observed. A few additional columns also appear in range tables for shrapnel which do not appear in range tables for shell or shot. Thus, in shrapnel fire, it is of interest, in addition to knowing the fuze setting for graze burst, to know—assuming the accuracy of fuze functioning—how much the burst will be displaced if the fuze setting is changed a given amount, and what will be the opening of sheaf. To compute, let us say, the displacement of burst of 0.5 sec. in the fuze setting one need only know the angle of fall, terminal velocity, and the ratio of the fuze setting for graze burst to the time of flight. From the angle of fall and the terminal velocity one could obtain the horizontal and vertical components of the velocity from the relations.

$$V_x = V\omega \cos \omega$$
$$V_y = V\omega \sin \omega$$

where

V_x is the horizontal component of the velocity
V_y is the vertical component of the velocity
$V\omega$ is the terminal velocity
and ω is the angle of fall.

The displacement of burst for 0.5 sec. change in Fuze Setting can then be expressed by the relation

$$\Delta X = 0.5\ V \cos \omega \frac{T}{F.S.}$$

$$\Delta Y = 0.5\ V \sin \omega \frac{T}{F.S.}$$

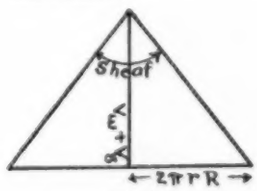


Fig. 14

where

ΔX is the displacement of the burst in the horizontal direction

ΔY is the displacement of the burst in the vertical direction
F.S. is the fuze setting for graze burst
and T the time of flight.

The projectile in its flight has a velocity of rotation and one of translation. When the projectile bursts the velocity of rotation tends to throw the shrapnel balls in the direction perpendicular to the trajectory and the velocity of translation plus the velocity of the shrapnel balls, imparted to them by the bursting charge, tend to hurl the shrapnel balls in the line of the trajectory, so that the opening of sheaf (the angle of the cone formed by the shrapnel balls) $= 2 \tan -1 \frac{2\pi r R}{V\omega + V_s}$

where R is the number of revolutions made by the projectile per sec., computed from the relation

$$R = \frac{12V}{nd}$$

where V is the Muzzle Velocity in f/s;
n, the twist at the muzzle in calibers;
d, the diameter of the bore in inches;
r, the radius of the projectile;
V_s, the velocity of the shrapnel balls.

Antiaircraft Fire—9 pt. Ant.—

The observation in antiaircraft fire is done either by mirror or window position lnders. Here it is necessary to correct to standard conditions not only the observed range and deflection of the point of burst, but also the altitude of the point of burst. The atmospheric conditions aloft are weighted for their effect not only upon the range (X) and the deflection (Z) but also upon the altitude (Y) of the point of burst. The times of flight for given fuze settings are observed and this is correlated with the pressure at the mean altitude of the point of burst for the purpose of enabling the computation of fuze settings for various conditions of fire.

The above chart (Fig. 15) showing trajectories and fuze setter curves, for standard conditions enables the gunner to determine the elevation and fuze setting for an aircraft at a given distance from the gun and at a given altitude or for one flying at any known altitude and a given angle of site as viewed from the gun. Mechanical time fuzes are now being developed which will eliminate the necessity of the determination of the fuze-setting-time relation. The curves of constant fuze settings will then be replaced by curves of constant times of flight.

Range Tables computed in the manner outlined above are issued by the Ordnance Department to the various combat branches of the Army, chiefly to the Field Artillery and Coast Artillery.

The Comptroller General *vs.* The Courts

THE following quotations from recent decisions of the Comptroller General may be of interest to such of our readers as are concerned with disallowances of their accounts or payments by the Comptroller General.

In a decision of February 7, 1924, upon the claim of Mr. Albert M. Allen, father of Joseph H. Allen, late seaman, United States Navy, for pay for his son from May 1, 1921, the date fixed by the Comptroller General as the date of loss of the *Conestoga,* to June 30, 1921, the date fixed by the Secretary of Navy as the date of loss of the vessel, the Comptroller General says:

"The heirs of one Harry P. Quinn, who was also a member of the crew of the *Conestoga,* brought suit in the Court of Claims for pay for the period from April 30, 1921, the date fixed, as aforesaid, by this office, as the date of loss of the vessel and her crew, to June 30, 1921, the date suggested by the Secretary of the Navy for acceptance as the date of loss, and in a memorandum opinion dated July 9, 1923, the Court concluded that the date of loss of a vessel of the navy was to be fixed by the Secretary of the Navy, and that the accounting officers were without authority to fix any other date than that reported by the Navy Department as the date of loss."

The Comptroller General quotes the following from the Court's memorandum opinion:

"The information as to the loss and the date of it should come from the source best qualified to furnish it. The Secretary of the Navy, through those connected with the Navy Department, is in position to know the status of naval vessels."

The Comptroller General further states:

"The opinion of the Court • • • holds • • • that under Section 28 U. S., Revised Statutes, the determination of the Secretary of the Navy as to the date of loss is conclusive on this office."

The Comptroller General then states:

"Under the Act of June 10, 1921, responsibility to settle and adjust claims against the United States, and to determine the availability of appropriations for their payment is upon this office and while opinions of the Court are given most careful consideration, especially where it appears that the merits or legal principles involved have been fairly presented to and fully considered by the Court, it is not believed that this office would be justified in applying the decision in the Quinn case to the case here under consideration."

In a letter to the Chairman, United States Employees' Compensation Commission, dated February 26, 1924, the Comptroller General says with reference to the payments made or to be made by the Employees' Compensation Commission:

"This is a question for determination solely by the Comptroller General of the United States and may not be adjudicated by any Court. While the courts may render judgments against the United States in certain cases such judgments are payable only after specific provision for such payment is made by the Congress and upon settlements made by the General Accounting Office. Under the Constitution of the United States money can be drawn from the Treasury only in consequence of appropriations made by law; and the only means provided under existing law for taking appropriated moneys out of the Treasury is by warrant, and no such warrant is valid or effective until countersigned by, or under the direction of, the Comptroller General of the United States."

Crystal Deformation in Cold-Worked Steel

By

H. H. LESTER

IN dealing with cold-worked steel in Watertown Arsenal laboratories, the questions come up insistently: "What causes the increase in tensile strength when steel is cold-worked?" "Why should it be harder and more brittle?" Metallurgical literature of the past few years has contained much concerning the constitution of metals, the theory of hardening by cold work, and various other pertinent questions of metallurgy. One sees much concerning grain fragmentation, slip interference, and learns that the theory of hardening has been "lifted out of the field of speculation." Nevertheless, one does wonder at times as to just why grain fragmentation causes increased hardness and tensile strength and the easily remembered answer "slip interference" still leaves a vague doubt. The answer seems a bit incomplete. The practical aspects of the problems involved in plastic deformation is of great importance to the Ordnance Department, and at Watertown Arsenal an attempt is being made to get more specific information based on experiment. This information must be gained from a more complete knowledge of the interatomic forces in metals, the forces that give metals their rigidity. As a first step in this direction a study has been undertaken of the behavior of atoms within the iron crystal as it occurs in steel when the metal is stressed up to and beyond the elastic limit, and up to and beyond the yield point. This paper is concerned with this preliminary study.

Steel and iron and, in fact, all metals are crystalline. That is, they are made up of small crystals, which are usually small, and in steel are often microscopic. These crystals are held together by strong cohesive forces to form an apparently homogeneous mass of metal. The crystals themselves, though small, consist of many thousands of atoms arranged in a definite geometric pattern. This pattern is formed by the tendency of the atoms to fall into positions of stable equilibrium under the influence of the interatomic forces and represents the arrangement in space of the atoms in a configuration of stable equilibrium. Given a sufficient freedom of motion all the atoms of a mass of metal would form one large crystal, and all forces on each atom would be balanced in all directions. In practice, however, the atoms in metal cooling from the liquid state begin to form stable configurations at many points. The result is many small crystals instead of one large crystal. The more rapid the cooling, the greater the tendency to form small crystals. The atomic arrangement in the crystal depends upon the nature of the atoms and their energy content. Thus we have one geometric pattern for zinc and another for iron. We have also two or more configurations for iron, depending upon the temperature of the iron.

In ordinary carbon steel at room temperature, the crystal formation is made up of an indefinite repetition of a unit crystal structure in which the iron atoms are arranged at the corners of a cube with one atom at the center of the cube. The unit structure is called the crystal lattice, and the crystal lattice for iron is called a body centered tube. The arrangement of the carbon atoms with reference to the iron atoms is not definitely known as yet. It is known that the main constituent in carbon steel at room temperature consists of the body centered cubic crystals of iron. It has been pointed out above that the atoms in the crystal are in the positions of stable equilibrium, and that the forces holding them in place are balanced in all directions. If an atom is displaced from its position of equilibrium, restoring forces are brought into play that tend to return the atom to its stable position. These forces are the elastic forces of the crystal. They give the crystal its rigidity. In addition to these elastic forces in the crystal there are cohesive forces that hold crystals together. These forces are also atomic and are similar to the adhesive forces that cause water to stick to a wet surface; they are similar to the cohesive forces between molecules that cause water to have tenacity. These cohesive forces are of the same nature as the forces within the crystal, and differ only in that they are not balanced forces. The boundary atoms in the crystal are not in stable equilibrium. They tend to move into position of stable equilibrium, and actually do so when given sufficient freedom of motion. This fact is illustrated by the well-known phenomenon of grain growth when metal is heated to a high temperature and slowly cooled. In ordinary annealing processes there is a partial movement of the atoms into positions of greater stability.

The cohesive atomic forces between crystals and the atomic forces within the crystal both tend to resist deformation of the metal, and both are represented in the elastic constants of the metal as determined by the laboratory testing machine. To what extent are the cohesive forces between crystals and to what extent are the forces within the crystal responsible for the constants as determined by the usual testing methods? We have reason to believe that the intercrystal forces are elastic because in a liquid, such as mercury, where the atoms are in neutral equilibrium, and where all of the interatomic forces are similar to the intercrystal force, there is a very decided bulk modulus of elasticity. We know also that cold-working metal increases its elastic yield point and rigidity. Cold-working causes a breaking up of crystals into smaller ones, and consequently increases the cohesive intercrystal forces at the expense of the balanced system of interatomic forces within the crystal. This and other evidence seems to indicate that the atomic forces that cause the crystals to cohere are greater than the atomic forces within the crystal. This deduction would be very important to the steel treater if it could be accepted as fact. Unfortunately, information as to what fundamental

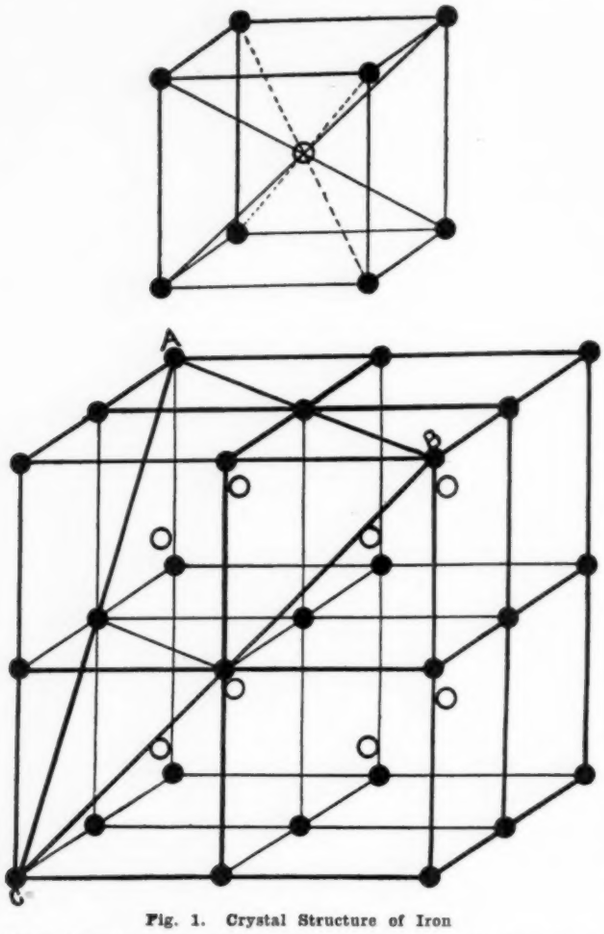


Fig. 1. Crystal Structure of Iron

Above: Graphic representation of an iron crystal unit; below: an iron crystal containing 8 crystal units.

factors control elasticity, strength, and other physical properties is not sufficient to warrant deductions. It is hoped that the X-ray diffraction method will supply some of the essential information needed.

To explain how the X-ray diffraction method may be applied to the solution of the problem of the elastic forces within metal, it is necessary to recall the fact that the crystal structure is made up of an indefinite repetition of a unit structure in which the atoms are very exactly placed in a very definite geometric pattern. This structure causes the atoms to fall into parallel layers or planes, moreover there are a great number of systems of parallel planes depending upon the angle from which the crystal is viewed. This point is illustrated in Figs. 1 and 2. In Fig. 1 is shown the unit crystal of iron and a crystal made up of eight such units. In this crystal, ABC represents the intersection of one of these atomic planes with the crystal. Other planes may be drawn parallel to ABC and a system of such planes may be drawn so as to use up every atom in the crystal. The planes of such a system will be found to be equally spaced, that is, the perpendicular distance from one plane to its nearest neighboring plane is the same for any two consecutive planes. Fig. 2 shows the face view of an iron crystal containing a great number of unit crystals. Several sets of parallel planes are illustrated. "d" represents the planar spacing which is seen to be constant for any particular set of planes, but varies from one set to another. When X-rays strike a system of these atomic planes they are partially reflected from each of the component planes of the system according to the well-known law of reflection of light in which the angle of incidence equals the angle of reflection. Since there is reflection from each of the planes of the system, the reflection from one plane will interfere with reflection from its neighboring planes. That is, when the reflected rays from the various planes are *in phase* there will be a reflected ray, when *out of phase* there will not be a reflected ray. The theory of this interference of X-ray diffraction was worked out very beautifully by Professor W. R. Bragg, and is published in his "X-Rays and Crystal Structure." He shows that there will be a reflected ray when

$$\lambda = 2d \sin \theta$$

where λ is the X-ray wave length, d is the interplanar spacing, and θ is the angle of reflection. Bragg had in mind a single crystal. Debeye and Shearer, in Europe, and Hull, in this country, have shown that the method can be applied to a mixture of small crystals that are oriented in all possible ways. Just how this principle applies to steel is illustrated in Fig. 3, where the X-ray beam of known wave length is shown striking one of the multitude of small crystals of which steel is composed. In any one crystal it is not likely that more than one set of planes will be oriented correctly to give reflection from more than one set of planes, but other crystals will be oriented correctly for reflection from other sets of planes. The incident X-ray beam passes through the crystal along the path marked "zero beam," in Fig. 3, and may be caught on a photographic film. The image formed is the zero point from which the angle is measured between the zero beam and the reflected beam, which also is caught on the same film. The film is usually bent around the arc of a circle with the metal specimen at its center so that the distance from the zero point to the re-

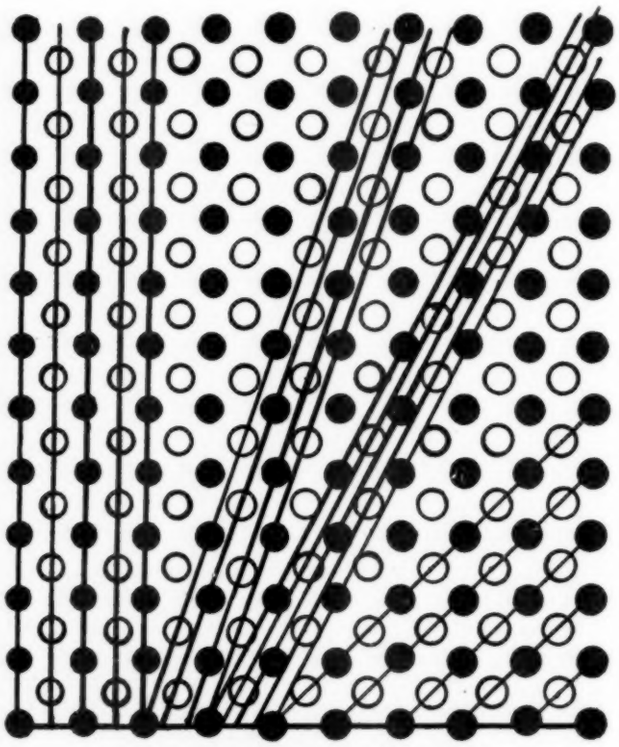


Fig. 2. Face View of an Iron Crystal

The solid circles represent corner atoms; the outlined circles represent cube center atoms.

flected image measures twice the angle of reflection, or 2θ. θ is also the angle of incidence. The angle which the incident ray makes with the horizontal is also known, so that the angle which any given set of reflecting planes makes with the vertical may be determined. The significance of this point may be understood by a study of Fig. 4.

Fig. 4 shows the actual application of the diffraction method to the study of elastic deformation of the metal crystals. A thin steel ribbon was suspended in a vertical plane and placed under a known tension, which was within the elastic limit of the material. An unstressed ribbon was suspended alongside, both being in the same vertical plane. A flat beam of X-rays was passed through the two specimens, making a horizontal intersection with the specimens. This beam made an angle of 7° with the horizontal. The position of the zero beam and one reflected beam are shown, and below the point of reflection parallel lines are drawn, showing the actual direction of the atomic planes that are producing the reflection. The direction of "d," the perpendicular distance between planes is also shown. It is seen that the atomic planes, make an angle of $(\theta—7°)$ with the horizontal plane. This angle, marked ϕ in the figure, is also the angle made by "d" with the vertical plane. The stress in the material may be resolved into components parallel to and perpendicular to the atomic planes. The perpendicular components tend to separate the planes. The parallel components tend to slip the planes past each other parallel to themselves. The diffraction machine measures the value of "d." The position of the reflected image depends upon "d." The images due to reflections in the unstressed specimen do not quite line up with the images due to reflection from the stressed specimen. This shift in the image may be measured, and from this shift the change in the value of "d" may be calculated.

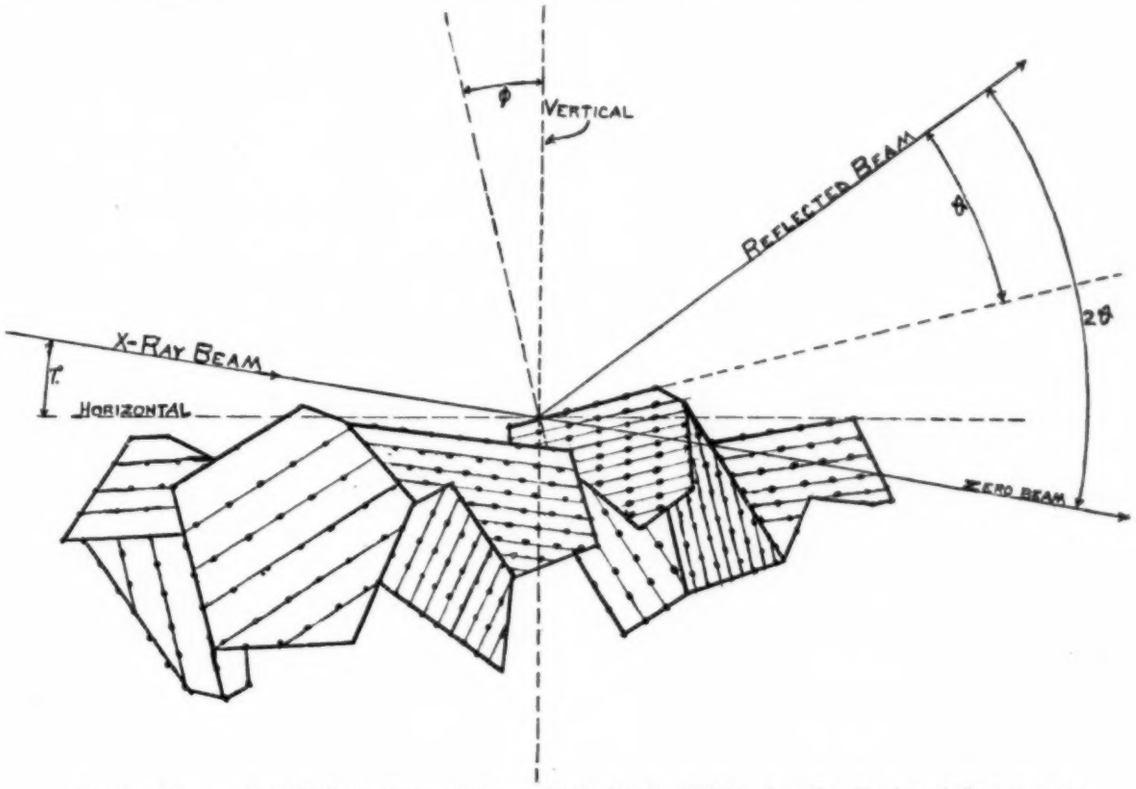


Fig. 3. Diagram Showing X-ray Beam of Known Wave Length Striking One of a Number of Steel Crystals

This measurement makes possible the determination of the actual separation of atom layers under stresses. It is of interest to know how the atoms in the crystals are shifted when stresses are applied up to and beyond the yield point of the metal, and if there is a complete recovery of relative orientation upon removal of the stresses. Inferentially some information may be gained as to the relative parts played by the intercrystalline atomic forces, and atomic forces outside the iron crystals in the elastic behavior of metals.

Mr. R. H. Aborn, of the Watertown Arsenal laboratory staff, has undertaken the laborious task of making these determinations. His work will be published in detail at a later date. We are anticipating this publication somewhat in using some of his results to illustrate the present paper. The results given below are from his work. Mr. Aborn was kind enough also to prepare the illustrations for this paper.

In Table I there is given a sample of the results obtained in stressing the metal ribbon referred to below the elastic limit. In the table, column 1 gives the film number; column 2, the miller indices that identify the planes; column 3, the load actually applied to the specimen in pounds per square inch. The 4th column shows the actual distance measured on the film for the unstressed specimen. The 5th column gives the value of "d," calculated from the data in column 4. The 6th, 7th and 8th columns give the per cent elongation in "d" as actually measured. These values were obtained by measuring the displacement of the lines on the two parts of the film. That is, the reflection from one set of planes for the unstressed specimen gave a line on the film that did not quite coincide with the line that marked the reflection from the same set of planes in the stressed specimen. This relative shift was measured and compared with the values in column 4 to get the per cent change in the value of "d." Many readings were taken, the maximum and minimum values for different planes found, and

The fact that the results are of the right order of magnitude is significant.

In later work it is planned to measure with greater precision the deformations under the elastic limit and to arrive at a value for the elastic moduli and Poisson's ratio for the iron crystals as exhibited in stressed metal. It is found that the relative displacement of the planes reach a maximum value at about the elastic limit. When the metal is cold worked the elastic limit of the metal is increased, but the deformation of the crystal at the new elastic limit is no greater than it was at the old elastic limit, at least along planes of least resistance to slip. The apparent mechanism of plastic flow would then be a gradual deformation of the crystal until slip occurs. After slip or during slip the crystal returns to its normal shape. The increase in the elastic limit and tensile strength of the metal due to cold work must depend on other factors than the atomic forces within the crystal.

Just why maximum values for the displacement should occur at the elastic limit in this experiment is not clear. Present evidence points to the conclusion that the elastic limit in steel is determined by the stress that produces slip along one or more favored planes. The yield point seems to be a point where simultaneous slip occurs along several glide planes with fragmentation of grains. At the elastic limit there is probably not very much grain fragmentation and there may be none. More evidence for the above points is needed and is being gradually accumulated. In the more complete publication of this research the above views may be considerably modified.

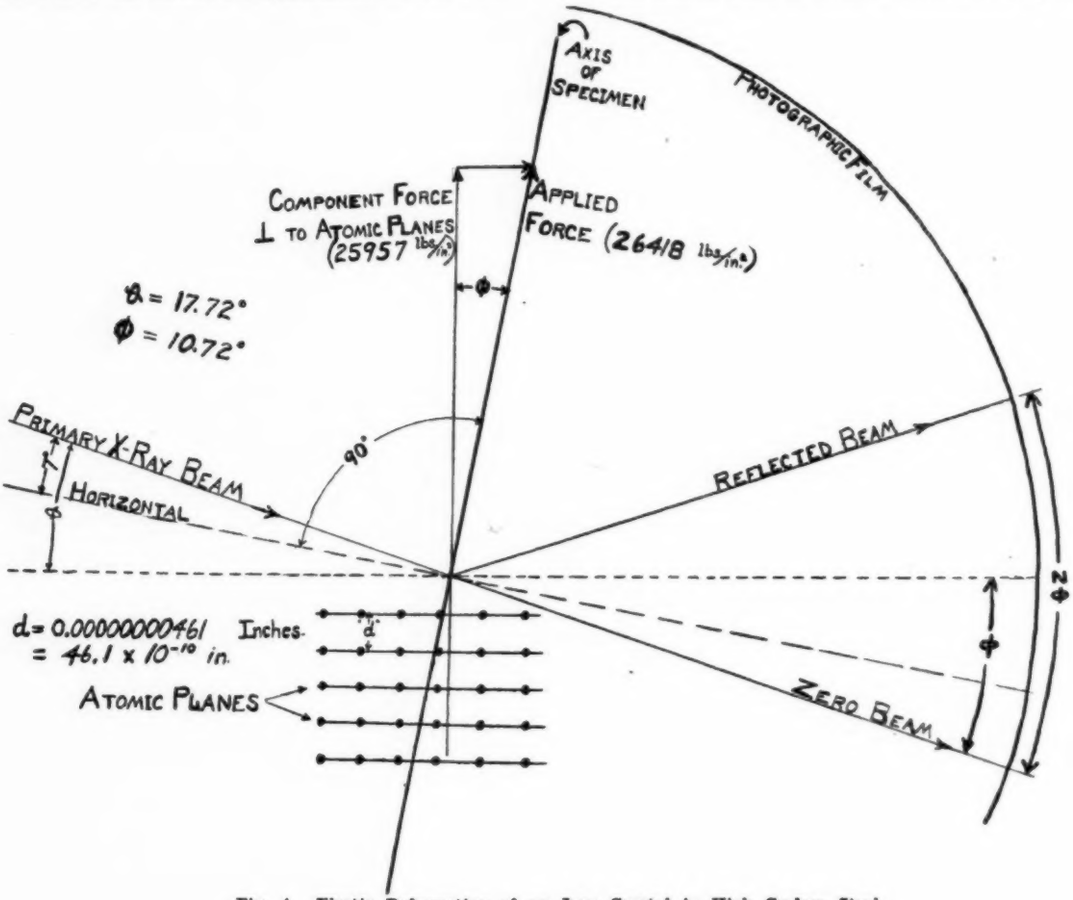


Fig. 4. Elastic Deformation of an Iron Crystal in High Carbon Steel
Figures taken from Film A-8 for 211 Systems of Planes.

TABLE I.

Elastic Distortion of an Iron Crystal in Carbon Steel.

Film.	Plane System.	Load on specimen in lbs. per sq. in.	Distances from zero point to reflected images on film.	"d" for unstressed specimens in inches X1012.	Per cent change in "d" in the stressed specimen.			Calculated averages Per cent changes in "d," using modulus for the specimens.
A-8	110	26418	2.826	7976	+.071	—.025		
A-8	100	26418	4.019	5640	—.199	—.199	+.0867	+.0862
A-8	211	26418	4.949	4605	+.404	—.101		
A-11	110	74276	2.826	7976	+.743	—.035		
A-11	100	74276	4.019	5640	+.398	+.124	+.2654	+.2423
A-11	211	74276	4.949	4605	+.404	+.040		

Origin and Development of Weapons

By

FRANK L. LAZARUS

THE development of man, since the beginning, has been marked by a distinguishing attribute by which he differs from all other animals inhabiting the earth; that attribute is reason. He has ever been capable of realizing that he performed certain actions intuitively, and he has asked himself: "Why?" By this process civilization has progressed slowly yet surely. As he advanced, solving his problems, he accumulated a vast store of data, correct and incorrect. Time and experience sifted this data until only the true remained. These records are the mainstays of civilization. Man builds, using them for his foundations, thus his work cannot sink back from the heights to which he raises it. These records enable man to ascertain what will function and what will not. For, as long as man retains human form and characteristics, as long as he remains upon this world, he will be essentially the same. A pin will prick him. Water will wet him. The sun will warm him. Knowing that history repeats itself, and being informed of the past by his records, he is enabled to work for advancement, without wasting time in experiments doomed to failure.

Hastarius with Pilum

There is no instinct older, or more fundamental, than that of self-preservation; it is primary and exists in all forms of life. Naturally, one of man's first concerns was: "How can I best secure food and protect myself against my enemies?" Thus did it come to pass that man first gave thought to the origin and development of weapons. And we can safely say that in no other pursuit has man spent so much time and employed so great ingenuity.

Because man fashioned innumerable weapons, he left many relics. These relics indicate the order of development, and viewing them in the light of our experiences, and the experiences of our predecessors, set forth in their records, we can trace the gradual evolution of weapons down to the present.

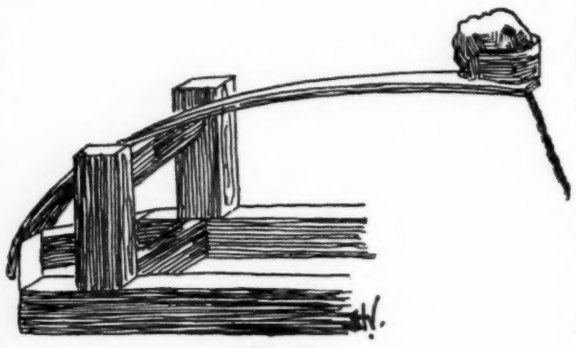
From the facts preserved in the records, there have been derived certain principles which the passage of time has tended to ratify. Probably the most fundamental of these is the principle of evolution, which maintains the development of form out of form in a connected series with the survival of the fitter forms in adjustment to environment. This principle appears to be universal and of course controls the development of weapons; but there is another principle, more directly applicable in this respect which causes the variations that are the impulses to evolution. It may be stated as follows: man's primary object in combat is to harm his enemy and at the same time to receive the least injury himself. And as a corollary we have: man attempts to keep as far from his enemy as possible while injuring him.

Back in the early ages man possessed three natural weapons with which to secure food and defend himself against the enemies that threatened his exsitence, namely, his teeth, feet, and hands. In the beginning he might have fought with his teeth. Later he may have come to depend on his arms and hands as his main means of defense. The feet have never been employed to any great extent as a weapon because man has always stood on his feet, and has consequently found it difficult to use them for any other purpose; bare feet are not a particularly effective weapon. Thus we see that man's first real weapon was the hands, and he must have used them as such through a vast extent of time, for to this very day, he will, when inflamed with anger, forget the knowledge which experience has imparted to him, and fight with his hands, even though other weapons may be available. There is an apparent exception to this statement in the case of the natives of the southern European countries who will almost invariably seize some object with which to fight. But if we consider, we will see that this apparent exception is no exception at all. It only serves to show that the ancestors of the natives of southern Europe used weapons before the ancestors of the natives of northern Europe, and therefore, the southerners have become more accustomed to depend upon weapons in combat. It does not mean that they are more cowardly than the northern races, but only that they have the lessons of civilization and experience more deeply inculcated in them.

At divers times a man, who was holding a stone or some other object in his hand, was attacked without warning by an enemy; naturally the man struck back at his assailant without waiting to drop the stone or other object. To his surprise he found that the effect was much worse than it had been on other enemies whom he had hit with only his hand. Inasmuch as the contestant who held no object in his hand was at a disadvantage against the one who did, the practice of holding a heavy object in the hand became the rational method of waging combat.

In those distant days which we are now describing man

was in an extremely low stage of development. He was just becoming capable of connecting cause and effect, of realizing that there was a reason why certain things happened and others did not; but more than this he could not do. Consequently, when two men held different views concerning a question one could not convince the other of his error by reason, but had to use the only means at his disposal, namely, force. So there were many quarrels in those troubled times, and it was inevitable that in one of the resulting fights a man should fail to hit his enemy squarely with his hand, but should nevertheless, strike him a glancing blow with part of the stone which he was holding in his fist. In consequence his opponent was injured as seriously as if he had hit him with his fist, and moreover, his fist had not been hurt in inflicting the injury. So man learned the advantage of striking blows with the part of the stone that extended out of the grasp of his hand; and thus the stone replaced the fist as the most effective weapon of the time. However, it was extremely difficult to find a stone which was wieldy and yet extended far enough out of the grasp of the hand to constitute a weapon; thus, branches and small trees were used instead of stones. And the club came into existence as a weapon.



Catapult

The club was used without modification for a long time until the idea was conceived of topping it with the stone which he had formerly held in his hand. Then came such refinements as putting an edge on the stone, using harder stones, and so on, till finally man had the tomahawk and stone axe. Later, when he acquired the art of working with metals, he made battle axes of iron and steel. Other weapons, the origin of which can be traced to the club, are the spear, which is a long, sharp-pointed club, and the sword, which is nothing more than a steel battle axe with an elongated edge. The sword represents the acme of development along this line, and because of its superior advantages it has replaced all the others.

Another method of harming one's enemy which came into existence at the same time as the club, or perhaps a little before, consisted in throwing stones at him. One can very easily deduce from his own experience that the manner in which this method came to be discovered was as follows. When man was fighting with a stone in his hand, as we have seen was the custom during an early period of his development, it often happened that the centrifugal force, engendered by swinging the arm to deliver a blow, wrenched the stone from his hand and sent it hurtling at his opponent. Man soon realized that this was a good way to injure his enemies without going near them; so he adopted it, and during approximately the same period there were two weapons in general use, the club and the stone thrown by hand. However, in order to strike a target effectively, one cannot be much farther from it when he hurls a stone than he must be when he uses a club. And furthermore, a club can be used to strike any number of blows in quick succession, whereas a stone once hurled is gone. Hence, inasmuch as the wielders of the club had the most advantages, they usually killed those of their opponents who depended on stone-throwing. So the club users survived the stone throwers and their method of fighting naturally became generally accepted.

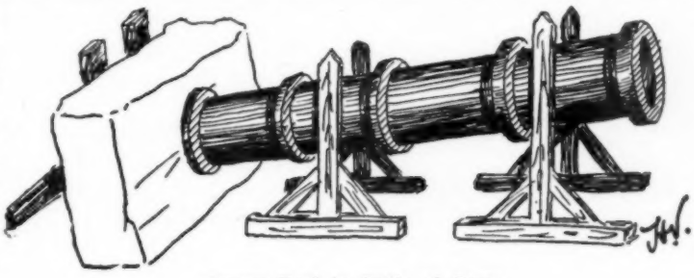
From the time when man had begun to use stone heads on his clubs he had fastened them there with leather strips torn from the hides of animals. Sometimes when the club was swung to strike a blow, the centrifugal force so produced would tear the stone from the end of the stick and send it flying through the air for a great distance. Thus it was demonstrated that he could hurl a stone at a distant object with terrific speed if he were only able to release the stone from his club at the proper instant. Later he found that he could better control the time of departure of the stone if he secured it on the end of a strip of leather instead of a club. Thus was discovered the underlying principle of the sling, and it was only a matter of time until he produced the weapon itself.

The sprung branch or tree struck quite a powerful blow, but it had no range. It was only able to injure people who were very close to it. So, before it could become a practical weapon its range had to be increased. Finally, some one realized that stones and other heavy objects could be hurled through space by the force of the branch or tree springing into its normal position. Thus did the catapult come into existence, and it was not long before its highest state of perfection was reached. The ballista and bow are forms of the catapult, and the arrow is a spear which is thrown by these miniature catapults. The cross bow is an improved form of bow.

There are many conflicting stories, legendary and historical, concerning the origin of gunpowder. However, from a careful study of these records we are able to conclude that the "thunder and lightning" with which the Oxydracae repelled Alexander's invasion of India, and the Greek and Chinese fire of which history speaks, were nothing more than incendiary compositions used to strike fear into the hearts of superstitious enemies. These mixtures consisted of brimstone and saltpetre, and were discovered accidentally, by the use of those chemicals as fuel.

Roger Bacon was the first man to discover gunpowder. He derived a practical formula in 1270 while experimenting with an incendiary composition. During the 13th century, Berthold Schwartz and other alchemists arrived at similar formulae. Their mixtures contained brimstone, saltpetre, and charcoal. These men carried out many experiments and found that when the gunpowder was put in fire, the force of the explosion hurled even the heaviest fuel from the fire in all directions. So in subsequent experiments, in order to prevent this dangerous scattering of fuel, a hole was dug, and the explosion produced therein. It was found that under these circumstances the fuel was thrown out only in the direction of the mouth of the hole; and it was further found that heavy objects, such as stones, could be hurled by the force of the explosion. Thus the idea of using the phenomenon as a weapon was conceived. Explosions were produced in containers which had been filled with stones and pointed at the enemy. At first these containers were mere holes dug in the earth, but later, in order to make them port-

able, they were built of wood, and finally, in order to increase their strength, iron was used. Of course these first containers had no special shape; all varieties of shapes were tried until it was found that the cylinder gave the best results. These rude cannons were the forerunners of the great howitzers, mortars, and super-rifles of today. The rifle is a miniature cannon and the machine gun is nothing more than a multiple rifle. The characteristics of the projectiles fired by these guns have also changed whenever conditions necessitated a change. For example; armor-piercing shells were invented to penetrate the deck armor of modern battleships, and, when infantry changed its mode of attack from close to open order, shrapnel was invented to give the projectile a greater area of effectiveness.



Cannon Used in Battle of Crecy

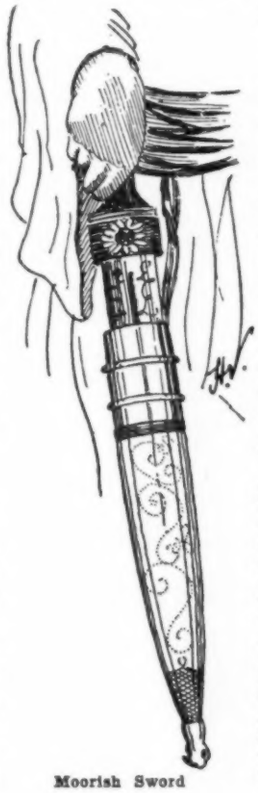
And what practical lesson does this narrative hold in store for us. On analysis we find it to be nothing more than a chronicle of the manner in which man satisfied his needs. By satisfying these needs he raised his condition, and thereby complicated existence and introduced new needs. Thus did civilization advance, ever giving rise to new needs. But the significant fact to note is this: man has never failed to supply himself eventually with those things he really needed. Bearing this in mind we have only to determine what man is striving for, and we will be able to determine what he will have in the future. Necessity is the mother of invention. Whatever is designed to satisfy a certain necessity will possess the characteristics required to bring about the desired conditions. This is only another way of stating our primary principle; everything tends to adjust itself to the environment in which it exists.

Artillerymen are endeavoring to increase the mobility and accuracy of their guns. Mobility depends wholly on the improvement of transportation, such as tracks and tractors, and on the simplification of gun structure. Accuracy requires exact measurements of distance and direction, and of meteorological conditions. The design of powder and projectile must likewise be improved. Greater ranges will probably not be considered, because they could be obtained only at the expense of mobility. Besides, long range firing necessitates a system of beyond-the-horizon observation which is extremely inaccurate. Taking everything into consideration, it is best to have accurate guns that can be moved quickly to sheltered positions near good observation posts.

Greater safety and destructiveness are the requirements of the Air Service. The dangers of flying are being lessened by improvements in plane construction and by more thorough training of pilots. So far as destructiveness is concerned the bombs and machine guns now in use are more or less satisfactory, but airmen must learn from training and experience to make more accurate use of them. The needs of the infantry are those of the entire army. Theoretically, the value of the individual soldier would be increased if he had greater courage, stamina, and speed; but those are characteristics over which man has little control. They have been the same since the dawn of history; they will most likely remain so. Therefore, help for the infantry must come from the other branches. If it needs more protection the Engineer must improve trench design. If it requires more information, the Air Service must better their methods of observation. If it is held up, the Artillery must destroy the obstacles in its path.

The non-combatant arms are also seeking greater efficiency. They will get it through thorough organization, careful training of personnel, and cooperation with the other branches.

Such are the ends toward which the combat-arms are aiming. Now let us consider the question of tactics. Are armies trying to improve their defensive or offensive tactics? The answer is: they are working to improve both. For, whenever an offensive weapon is invented a defense against it must be improvised, else, like Frankenstien, it will return to destroy its creator. To some people the building of impregnable armor, and then, the designing of guns and shells to pierce it, seems foolish. If man's genius for defense it equal to his genius for offense (and it must be, else he would have destroyed himself long ago) why keep trying to improve weapons whose relative destructiveness must always remain constant? This question can best be answered by an analogy between the economic system and war. Let prices represent the offense and wages, the defense. Now, an examination of the last decade shows that the prices of commodities have steadily increased, but so have wages. Today the dollar will buy only half of what it bought in 1910, but, on the other hand, men are receiving twice as many dollars. So prices and wages are still relatively the same. True, the quality of goods has improved, but so have the tastes of the buyers. The standard of living has risen, we say. Why not try to keep it down? Because, granting for the sake of argument that you could, you would be suppressing man's natural desire for improvement. You would be retarding the progress of civilization, which is nothing more than the elevation of the standard of living. The struggle between the offense and defense is engendered by the inherent nature of man. As well try to curb it as to stop the journey of the moon around the earth.



Moorish Sword

And how will future wars be waged? In the first place, artillery will use nothing but guns. Howitzers and mortars will be discarded, because they are unnecessary and decrease mobility. The gun will fire separate loading ammunition (or possibly semi-fixed ammunition for rapid firing) and will be capable of use for either high angle or flat trajectory fire, by changing the powder charge, which will come in increments. Such a gun will never have to stand idle, as do the guns or howitzers of today when the location of the target precludes the employment of one or

the other. Moreover, mobility will be increased; as one type of gun will require only one kind of repair unit, one kind of powder supply, and one or two types of projectile.

The cavalry of the future will be mobile infantry. It will supply the patrols and messengers for the other branches; and, in emergencies, when troops are needed quickly at some place, cavalry will be sent.

For the infantry the basic principle holds, no territory is taken until it is occupied. However, the method of occupying territory will be slightly altered in the wars of the future. The improved accuracy of artillery and machine gun fire will make the advance of the infantryman extremely difficult, if not impossible during the time that the guns are functioning efficiently. Also, the use of gas will compel the infantryman to wear a mask and protective clothing that will cut down his speed and stamina. Therefore, the infantryman will be practically unable to advance until the hostile guns have been silenced or forced to retreat. Consequently, the infantry will lose much of its offensive character (though, of course, it will always be needed to drive out those enemies which the artillery has not destroyed), and its main function will be to take possession of the ground which the artillery has caused the enemy to evacuate, and to hold that ground against counter attack while the artillery moves up to the new position. Mind, it is not argued that the infantry will not be used in the attack, but only that they will play a less important part in actually driving the enemy out of a position, and that their greatest value will lie in their ability to hold ground from which the enemy has been driven, while the artillery advances.

Furthermore, in the future, as in the past, success will rest in the superiority of the individual; and this superiority will be gained, for the most part, through training. The day of the "political" officer is past, just as the day of the "newsboy to bank president without education" is past. Officers will have to be trained with great care. Officers and privates will have to be taught to think, and think correctly. War will be a science in the true sense of the word, and arms will really become a profession.

But, you say, there is nothing startling about these conclusions. They are perfectly obvious. Just a slight improvement over present-day conditions. And you are right. Yet the very lack of radical change is an argument in favor of the truth of these conclusions. For, look back at our record of the past. Has anything come suddenly or unexpectedly into general use? Was not the same formula always followed? First, the observation of a phenomenon, then the establishment of a principle, and, finally, the gradual development of the principle into a weapon. Even crowding the events of thousands of years into ten minutes of narrative, the development moves slowly, logically. How then can you expect an account of the next hundred years, extended over an equal length of narrative, to appear less prosaic. If anything, the development ought to seem infinitely slower.

Thus we come to the conclusion that, in the next hundred years, nothing fundamentally different from that which we have today can be expected. New inventions may be made, but they will not be developed into practical weapons within the century.

However, in the history of the world, a hundred years is but a meagre span, therefore, let us see if we cannot go further into the future and determine what the centuries will bring. Scientists are making so many discoveries concerning the causes of natural phenomena that it ought not to be many centuries before man, himself, will be able to bring them about. And when he can do that, he may be able to destroy the world. For instance, science may learn to utilize light rays that can blind or kill men; to make gas shells that can destroy all life within miles of where they drop. Moreover, science has already learned that earthquakes, such as the recent one in Japan, are caused by the slipping of one earth stratum over another. A slip of a fraction of an inch can cause an earthquake. Therefore, in the future, when war becomes a battle of the sciences, it might become possible to place a sufficient quantity of powerful explosive between two earth strata, and the resulting explosion will cause a whole district, or even a nation, to fall in ruins. Medical scientists may invent ways of infecting the inhabitants of whole countries with plagues and pestilences. Agriculturists may be able to cause a blight to fall on the enemy's land and ruin his crops.

Then war will be a scientific struggle, a battle of brains. It will result in the extinction of nations and even races. It will cease to be a game for the brave, and become a merciless utilization of the forces of nature for purposes as opposite those for which they were intended as life is opposite death.

(Ed. Note.—The illustrations for this article were drawn by Cadet Herbert D. Vogel, U. S. M. A.)

Army Industrial College Graduates

HONORABLE Dwight F. Davis, Assistant Secretary of War emphasized the great saving in men and money which follows as a result of industrial preparedness at the closing exercises of The Army Industrial College in Washington, June 25, 1924.

The Assistant Secretary said "It is always difficult to estimate what might have been saved during a war by adequate preparedness. Those in a position to form an estimate of what might have been done in the way of industrial preparedness for the World War have placed the possible savings at five billion dollars."

Those who completed the course were: Lieutenant Colonel Ira F. Fravel, Air Service; Lieutenant Arthur Lynch, Quartermaster Corps; Major Sanford W. French, Medical Corps; Major W. A. McCain, Quartermaster Corps; Major Lawrence Watts, Signal Corps; Major John K. Clement, Ordnance Department; Major R. H. Somers, Ordnance Department; Lieutenant Harry O. Tunis, Engineering Corps, and Lieutenant Harry R. Lebkicker, Chemical Warfare Service.

H. M. T. D.—A New Detonating Explosive*

By

C. A. TAYLOR and W. H. RINKENBACH

Hexamethylenetriperoxidediamine (H. M. T. D.) is a detonating compound, manufacture and use of which has been patented in Germany. It has recently been made the subject of an investigation by the explosives chemical laboratory of the Pittsburgh experiment station, United States Bureau of Mines, to determine whether it could be used as a substitute for mercury fulminate.

Legler[1] discovered H. M. T. D. while working on the slow combustion of ether. He obtained a solid, which, on treatment with ammonia, gave this compound, and noted some of its properties, including that of exploding on quick heating. Baeyer and Villiger[2] later carried out a more complete study of its preparation, properties and structure.

In 1912 von Girsewald announced[3] a new method of preparation, and in the same year patented the use of this substance as a primer and detonator[4], and also the method of manufacture[5]. In 1917, Leulier[6] published another method of preparation, and the results indicated that the compound had a constitution other than that previously assigned to it. However, von Girsewald[7] repeated Leulier's work, showed that the latter's new formula was incorrect, and later[8] suggested a somewhat different structure than that previously accepted.

Preparation of H. M. T. D.

Von Girsewald recommends dissolving 28 grams of hexamethylenetetramine (H. M. T.) and 42 grams of citric acid in 140 grams of 30 per cent hydrogen peroxide. He states in the patent specifications that the temperature of the solution rises, and a voluminous mass of H. M. T. D. separates out in the form of white, rhombic crystals. These are filtered off, washed with water and then with alcohol, and dried.

The directions given by von Girsewald are misleading. We found that the reaction is very rapid, and sufficient heat is developed to decompose the H. M. T. D., and the product first formed is oxidized without explosion, but with the evolution of considerable heat. Our experiments showed that the temperature should be kept below 30° C. during the reaction.

The modification of von Girsewald's method finally adopted by us was as follows: 56 grams of H. M. T. were dissolved in 185 grams of 30 per cent H_2O_2, or its equivalent of solution between 30 and 40 per cent. While cooling the mixture with a water-bath, 84 grams of powdered crystalline citric acid were then added, and the mixture stirred until all of the acid went into solution. The temperature was not allowed to rise above 30° C., and stirring was continued until the temperature began to decrease. The mixture was allowed to stand in a bath at room temperature for 6 to 15 hours, and was then filtered. The solid on the filter was washed several times with distilled water, and then rinsed with 95 per cent alcohol to facilitate drying. It dried quickly at room temperature. The undiluted filtrate was allowed to stand for several hours, and any additional precipitate was filtered off, washed, rinsed, dried, and added to the first portion obtained. From 68.5 to 71 per cent of the theoretical yield calculated from the weight of H. M. T. was obtained in each test.

From 56 grams of H. M. T., 280 grams of 30 per cent H_2O_2, and 84 grams of citric acid, a yield of 46.7 grams of H. M. T. D., and 285 grams of clear filtrate was obtained.

The filtrate deposited no more solid on standing for several days. It was a yellowish, slightly syrupy liquid, easily miscible with water. It contained free H_2O_2, and was strongly acid with citric acid. It was made up to two liters, and aliquot portions were distilled with KOH in order to determine the amount of ammonia present. It contained 13.409 grams of NH_3 and no unoxidized H. M. T. The reaction, then, may be as follows:

$$C_6H_{12}N_4 + 3\,H_2O_2 = C_6H_{12}N_2O_6 + 2\,NH_3$$

Grams	56.0	83.577	13.602
Grams found		46.7	13.409
Grams lost		36.9	

The H. M. T. D. not recovered may have decomposed without forming NH_3, according to the reactions:

$$C_6H_{12}N_2O_6 + 12\,O = N_2 + 6\,H_2O + 6\,CO_2$$

This shows that 22.8 per cent of the nitrogen originally introduced into the system as H. M. T. did not enter into the formation of H. M. T. D. Citric acid is used to neutralize the ammonia as formed and allow the formation of H. M. T. D.

Physical Properties of H. M. T. D.

Density—H. M. T. D. forms a white, powdery mass of minute rhombic crystals, which have no odor and are non-hygroscopic under ordinary conditions. Its true density at 20°/20° is 1.57, yet its apparent density after being placed in a tube and tapped was only 0.66,

* Published by permission of the Director, Bureau of Mines, Department of the Interior.

1Legler, *Berichte*, 18, 1885, p. 3344.
2Baeyer, Adolf, and Villiger, Victor, *Berichte*, 33, 1900, p. 2,486.
3von Girsewald, C., *Berichte*, 45, 1912, pp. 2,571-2,576.
4D. R. P. 274, 522, September 14, 1912.
5D. R. P. 263, 459, September 14, 1912.
6Leulier, *Jour. pharm. chim.* 15, 1917, pp. 222-229.
7von Girsewald, C., *Berichte*, 54, 1921, p. 390.
8von Girsewald, C., *Berichte*, 54, 1921, p. 393.

and only 0.91 after being compressed in a detonator capsule under a pressure of 2,500 pounds per square inch.

Solubility—H. M. T. D. is only slightly soluble in most solvents at ordinary temperatures. The following table shows the solubility in some of the common solvents:

Solubility of H. M. T. D.

Solvent.	Grams per 100 grams of solvent at 22° C.
Water	0.01
Absolute alcohol	less than 0.01
Ether	0.017
Carbon bisulphide	less than 0.01
Carbon tetrachloride	0.013
Glacial acetic acid	0.14
Chloroform	0.64
Acetone	0.33

Sensitivity—H. M. T. D. detonates when struck a sharp blow, but a small quantity flashes like nitrocellulose when ignited, giving a flame several inches in length. Several samples were tested and found to require the impact produced by the fall of a 2,000-gram weight through a distance of 3 cm. in order to produce detonation, as compared with a fall of 0.25 cm. for mercury fulminate.

Various weights of H. M. T. D. were placed in No. 8 detonator capsules without reinforcing caps, subjected to a pressure of 1,000 pounds per square inch, and fired in the sand-test bomb. The weight of sand crushed in each case is given below, with comparisons for the same weight of charge of other detonating compounds:

Sand test with H. M. T. D., compared with other compounds.

Weight of charge,	Sand crushed, grams				Sand crushed by same weight, grams	
gram.	1	2	3	Average.	Mercury fulminate.	Cyanuric triazide.
0.050	3.3	3.3	3.2	3.3	—	2.6
0.100	6.3	6.8	6.8	6.6	—	4.8
0.150	10.2	9.4	10.2	10.0	—	8.0
0.200	17.7	14.4	15.5	15.9	3.8	12.2
0.300	25.0	22.1	23.9	23.7	7.8	21.5
0.500	44.0	42.4	41.2	42.5	16.5	44.2
0.750	66.4	64.9	65.2	65.5	26.5	65.5
1.000	86.3	87.1	86.6	86.7	36.6	78.6

These results show that H. M. T. D. is from 2½ to 3 times as strong as mercury fulminate, and slightly stronger than cyanuric triazide.

Initiator of detonation—In order to test the value of H. M. T. D. as an initiator of detonation, 0.40 grams of the explosive to be tested was weighed into a No. 8 detonator capsule, a desired charge of H. M. T. D. was added as a top layer, and pressed under 1,000 pounds pressure. The detonator so prepared was fired in the sand-test bomb. The sand crushed was weighed, and this weight indicated whether complete detonation of the high explosive had taken place. It was found that the use of a reinforcing cap was not necessary. Results are given in the following table:

Value of H. M. T. D. as an initiator of detonation.

Explosive.	Minimum detonating charge in grams.		
	Fulminate.	Hexamethylenetriperoxidediamine.	
		with reinforcing cap.	without reinforcing cap.
Trinitrotoluene	0.26	0.08	0.10
Picric acid	0.21	0.05	0.06
Tetryl	0.24	0.05	0.06
Ammonium picrate	0.8 to 0.9	0.30	0.30
Tetranitraniline	0.20	0.05	0.05
Guanidine picrate	0.30	0.13	0.15
Trinitroresorcin	0.20	0.08	0.10
Hexanitrodiphenylamine		0.05	0.05
Trinitrobenzaldehyde		0.08	0.10

These results show that only from one-fifth to one-third as much H. M. T. D. as mercury fulminate is necessary to cause the complete detonation of these high explosives. It does not become dead-pressed under 11,000 pounds pressure, while mercury fulminate only burns under 10,500 pounds.

Rate of Detonation—Weighed charges of H. M. T. D. were placed in No. 8 detonator shells, subjected to a pressure of 1,000 pounds per square inch, crimped to a black powder fuse, and embedded in the sticks of dynamite. The dynamites used were an ordinary 40 per cent nitroglycerin dynamite and a gelatin dynamite, which was insensitive, due to storage for over a year. Five-hundredths (0.05) of a gram of H. M. T. D. detonated each one. The rate of detonation of H. M. T. D., determined by the explosives testing laboratory, was 4,511 meters per second in a file 0.22-inch in diameter, and a loading density of 0.88.

Effect of heat—An explosive is worthless and may be dangerous if it is not stable under all conditions existing during its manufacture and use. Samples of H. M. T. D. were placed on watch glasses, heated in electric ovens, weighed, and examined at intervals. The following tabulation gives the loss in weight:

Per cent loss in weight by heating.

Temperature.	60°	75°	100°
Loss in 2 hours	0.10	0.25	3.25
Loss in 8 hours	0.35	0.60	29.60
Loss in 24 hours	0.50	1.30	67.95
Loss in 48 hours	0.50	2.25	

The sample heated at 60° showed no signs of decomposition.

The color of the sample heated at 75° was unchanged. It had a faint odor of methylamine, and had lost its dry character; it now appeared slightly moist and tended to "pack." Three 0.300-gram charges of the material that had been heated 48 hours at 75° C. were fired in the sand-test bomb. The weights of sand crushed were 22.6, 22.1 and 21.9 grams, respectively, an average of 22.2 grams, as compared with 23.7 grams for the unheated material.

The sample heated at 100° gradually softened and gave off an amine odor. The residue after heating at 100° C. for 24 hours consisted of a colorless fluid and needle-like crystals, which were soluble in water.

Effect of Storage—When first made, 2-gram charges crushed 15.9 grams of sand. This bulk material was allowed to stand on a desk in the laboratory for three months, when it crushed 14.1 grams. Some of the original detonators were tested at intervals of a month after standing in the open, and gave the following results:

	1	2	3	4	5	Ave.
1 month	11.7	13.5	11.4	13.6	11.8	12.4
2 months	7.7	9.6	9.4	5.3	7.7	8.0
3 months	2.1	2.5	2.1	4.7	2.8	2.8

Other detonators were kept in an air-tight container, and at the end of three months gave the following results:

15.2	14.9	15.6	15.4	14.8	15.2

Two samples were stored in sulphuric acid desiccators for three months. One was stored in the light and the other in the dark. The first lost 0.25 per cent in weight, and the latter 0.28 per cent. Detonators made from the material showed no loss in efficiency. Four samples of 3 grams each were sealed in weighing bottles and examined after three months storage. Two were exposed to the light and two were kept in the dark during this

period. When opened all had the characteristic amine odor, but there was no apparent pressure developed, and 0.2-gram charges crushed an average of 15.0 grams of sand. Other samples were kept in small desiccators over water and crushed an average of 14.7 grams after three months storage.

The foregoing tests seem to indicate that equilibrium is established where the H. M. T. D. is stored in a closed vessel and that its efficiency is not materially decreased.

Hygroscopicity—Von Girsewald states that H. M. T. D. is not affected by water, even on long standing. In order to verify this statement, freshly prepared material was placed in a bottle, covered with distilled water, and allowed to stand for one month at room temperature. Five 0.300-gram charges were weighed into No. 8 detonator shells, and fired in the sand-test bomb. The remaining material was allowed to stand under water for another month, and the tests were repeated, giving the following results:

Time.	Sand crushed by 0.300 gm. charge of H. M. T. D. (grams).					Average.
Original	25.0	22.2	23.9	23.4	24.1	23.7
1 month	23.9	23.4	25.0	22.9	22.6	23.56
2 months	22.6	23.6	22.8	23.8	23.2	23.2

A quantity of H. M. T. D. was spread in a thin layer on a large watch glass, which was placed in a desiccator containing water, and the whole placed in an oven maintained at 30° C. for four weeks. At the end of each week some of the material was taken out, air dried, and five 0.300-gram charges were fired in the sand-test bomb. A slight amine odor was perceptible at the end of three weeks. Results are as follows:

Time. (Weeks)	Sand crushed by 0.300 gm. charge of H. M. T. D. (grams).					Average.
1	23.2	22.8	21.9	25.1	22.8	23.2
2	24.3	24.8	20.9	24.9	25.0	24.0
3	25.0	24.1	21.9	24.5	23.7	23.8
4	24.5	22.9	23.4	24.7	24.4	23.9

It is apparent from the foregoing that if decomposition takes place under these conditions, it does so to a very slight extent, and the residue is unimpaired as regards its explosive value.

That the presence of slight moisture will decrease this value was shown when, at the end of the fourth week, five shots were fired without previously drying the material. It was not moist, but showed a slight tendency to pack. The weight of sand crushed by 0.300-gram charges were 20.6, 22.2, 20.1, 19.6 and 18.3 grams respectively, an average of 20.2 grams.

Ignition temperature—When small quantities of H. M. T. D. were dropped on molten metal at 190° C., it decomposed, but detonated instantly at 200°. In three seconds, 0.05 gram ignited at 149° C., but decomposed without ignition at a lower temperature.

Chemical Properties of H. M. T. D.

H. M. T. D. is a neutral body, which does not appear to have any action upon metals or react with other substances to form addition products or molecular compounds.

Hydrolysis—Baeyer and Villiger, and Leulier, state that H. M. T. D. undergoes hydrolysis in acid solution. The writers of this paper found that hydrolysis will take place in acid, neutral, and alkaline solution, as shown by the following experiments:

Hydrolysis in neutral solution—Ten grams of the compound was added to 250 c. c. of distilled water, and the mixture boiled under a reflux condenser for half an hour. A tube led from the upper end of the condenser to a solution of ether, which was saturated with hydrogen chloride to catch any amines given off. The gas evolved contained oxygen, but no amines. The H. M. T. D. decomposed slowly in the water to a clear colorless liquid.

A portion of this liquor was analyzed for ammonia, and found to contain 95.3 per cent of that theoretically possible. Formaldehyde was also present. It is evident, then, that all, or practically all, of the nitrogen in this compound is transformed into ammonia on hydrolysis. This, together with the production of oxygen, would indicate the following as the equation of hydrolysis, as given by Leulier:

$$C_6H_{12}N_2O_6 + 6\,H_2O = 2\,NH_3 + 3\,C_2H_4\,(OH)_2 + 3\,O_2$$

The ethylene glycol then undergoes oxidation in the following manner:

$$C_2H_4\,(OH)_2 + 2\,O = H_2O + HCHO + HCOOH$$

Further reaction is then possible, the ammonia combining with the formic acid, and to a slight extent with the formaldehyde, to form H. M. T. All of these products were present.

Hydrolysis in acid solution.—Baeyer and Villiger, and Leulier, have previously studied the hydrolysis of H. M. T. D. with dilute sulphuric acid, and found the same reaction products as in neutral solution, so it was not considered necessary to repeat this work. However, it was found that this was also accomplished by organic acids at ordinary temperatures. Ten grams of H. M. T. D. was added to a solution of 42 grams of crystalline citric acid in 140 cc. of distilled water. It was found to be very slightly soluble, gradually going into solution with the evolution of oxygen, and gave off formaldehyde. It all decomposed in five days at room temperature. The solution so obtained was analyzed for ammonia and found to contain 85.4 per cent of that theoretically possible. It is evident, then, that the tendency to hydrolyze is increased by the presence of organic acids.

Hydrolysis in alkaline solution—It was found that when H. M. T. D. was treated with KOH solution, and allowed to stand at room temperature for a day, a strong odor of ammonia was given off, indicating that hydrolysis takes place in a manner similar to that in neutral or acid solution.

Oxidation of H. M. T. D.

If the reaction by which H. M. T. D. is produced is allowed to proceed unchecked, complete oxidation takes place, any of this substance at first formed being destroyed. In one test made by the writers, 28 grams of H. M. T. was dissolved in 140 grams of 30 per cent H_2O_2, and 42 grams of citric acid was added to the solution, which was stirred constantly. The temperature rose slowly to 34° C., and more rapidly to 45°, and apparently half of the usual yield of H. M. T. D. was precipitated. The temperature now rose rapidly to 80°, when violent boiling began, the temperature increasing to 111°. The precipitate of H. M. T. D. now decreased, and the appar-

ent volume of the boiling mixture decreased. The temperature reached 121° C. before the precipitate was all consumed. The yellowish syrup remaining in the beaker was allowed to cool to room temperature, and weighed 84 grams.

This residue formed a thick, yellowish syrup of somewhat pungent odor. It was not easily miscible with water, but dissolved with shaking, and was made up to 1 liter for analysis.

The solution was strongly acid and gave a test for citric acid. A determination of ammonia by distillation with KOH showed 9.75 grams to be present in the total residue. Alkali does not decompose H. M. ., so a portion of the solution was heated to boiling with 3 per cent HCl, as Hartung[9] has shown that this hydrolyzes H. M. T. to formaldehyde, ammonia, and a little methylamine. The acid solution was cooled, made alkaline with KOH, and distilled for ammonia. No increase was found, showing no unchanged H. M. T. to be present in the solution.

Reduction of H. M. T. D.

Since H. M. T. D. is easily hydrolyzed in either neutral, acid, or alkaline media, it is to be expected that attempts at reduction would be met with only hydrolysis. A test with sodium amalgam gave no evidence of the formation of a product of reduction, but showed hydrolysis.

Other Reactions with H. M. T. D.

Leulier states that when H. M. T. D is treated with nitric acid, oxygen is given off. Concentrated sulphuric acid or bromine cause explosion. He also found that in the presence of dilute acid, this compound sets iodine free from potassium iodide, and so he used this method to determine its oxygen content.

H. M. T. D. and Potassium Chlorate Mixtures

Mixtures of these two substances were made up and tested in the sand-test bomb. A 30-70 mixture would give complete oxidation, this ratio giving the following results:

Sand test of 30-70 H. M. T. D.—$KClO_3$ mixture.

Charge of mixture,	Sand crushed, grams.				Sand crushed by equal change
gram.	1	2	3	Average.	H. M. T. D., grams.
0.200 ------	10.5	11.0	9.5	10.3	15.9
0.300 ------	18.2	16.7	16.3	17.1	23.7
0.500 ------	29.4	27.7	27.5	28.2	42.5
0.750 ------	46.4	47.7	47.0	47.1	65.5
1.000 ------	62.3	63.6	61.2	62.3	86.7
1.500 ------	93.8	95.2	—	94.5	—

These results are only from 65 to 72 per cent as high as those given by equal weights of straight H. M. T. D.

Other mixtures were made up in an effort to find a composition that would have a greater crushing effect than straight H. M. T. D., and the results obtained were:

H. M. T. D.	$KClO_3$	Sand crushed by 0.75 gm. charge, grams.		
per cent.	per cent.	1	2	Average.
30.0	70.0	46.4	47.7	47.1
50.0	50.0	53.3	50.9	52.1
70.0	30.0	61.7	62.9	62.3
100.0	0.0	67.2	65.6	66.4

[9]Hartung.—*Jour. fur prakt. Chemie*, 2, 46 (year!) p. 16.

From this it is apparent that no mixture of these two substances will be more powerful than the pure H. M. T. D. Tests made on the small impact machine showed that these mixtures had the same sensitivity to impact as H. M. T. D. alone.

Physiological Properties of H. M. T. D.

H. M. T. D. is not an irritant, and does not cause dermatitis. It produces no other effect than violent sneezing when small amounts are inhaled. No apparent injurious effects were noted when it was fed to rats.

Composition of H. M. T. D.

Baeyer and Villiger, and von Girsewald, made a number of analyses of H. M. T. D., and agreed on the empirical formula $C_6H_{12}N_2O_6$, which the two former investigators checked by a molecular weight determination. Leulier announced this to be $C_4H_{11}NO_4$, but von Girsewald and Siegens[10] repeated his work, and showed his determination of the nitrogen content to be at fault, obtaining results which again confirmed the constitution as being $C_6H_{12}N_2O_6$.

Structure of H. M. T. D.

Baeyer and Villiger gave the structure the form (1)—

$$\begin{array}{c} / CH_2 - O - O - CH_2 \backslash \\ N - CH_2 - O - O\ CH_2 - N \\ \backslash CH_2 - O - O - CH_2 / \end{array} \qquad (1)$$

and this is the one commonly accepted today; but von Girsewald and Siegens[11] have since suggested the form (2)—

$$\begin{array}{l} O - CH_2 \backslash \qquad\qquad\qquad\qquad / CH_2 - O \\ \quad | \qquad N - CH_2 - O - O - CH_2 - N \qquad | \\ O - CH_2 / \qquad\qquad\qquad\qquad \backslash CH_2 - O \end{array} \qquad (2)$$

This does not differ essentially from the form commonly accepted, and either formula agrees well with the chemical behavior of the compound.

Summary

A study of the preparation and properties of hexamethylenetriperoxidediamine (H. M. T. D.) has shown the following:

1. That the patent directions must be modified in regard to temperature.

2. That the amount of hydrogen peroxide required in preparation is considerably less than specified by the patentee.

3. That the compound is more powerful and efficient as a detonating agent and considerably less sensitive to impact than mercury fulminate.

4. That H. M. T. D. is stable at temperatures up to at least 60° C.; it is not affected by storage under water; but it is slowly affected when subjected to high humidity at maximum summer temperature, and very slowly under ordinary storage, but it will not explode when moist. It is practically non-hygroscopic.

5. That it is less dangerous than the azides to prepare and handle, and is not poisonous.

[10]von Girsewald, C., and Siegens, H., *Berichte*, 54B (1921), p. 490.

[11]Work cited, p. 493.

Professional Notes

AMMUNITION DIVISION

Airways Parachute Flare

A new parachute flare (Fig. 1) for use in forced landings in night flying has been developed at Picatinny Arsenal and tested at the Aberdeen Proving Ground and McCook Field with excellent results. Since this flare was developed, however, additional requirements have been asked by the Air Service. The necessary modifications are being incorporated in the design at Picatinny Arsenal. Samples will be made according to this modified design and tested at Aberdeen and McCook Field. In the meantime, flares are being manufactured according to the present unmodified design so as to provide the Air Service with flares for use until such time as the improved design is available. The night landing flare has a candle power between 300,000 and 400,000 and burns for about three minutes. Its maximum weight is about 20 pounds, and an important part of the development work consisted in keeping the weight down to a minimum. The old Mark I Flare had the serious fault of occasionally allowing burning pieces of the flare to fall free of the parachute, giving danger of serious brush and forest fires. It is believed that this fault has been eradicated in this type of flare. The flare is so designed as to make the parachute positive in action, and is capable of being operated from the bomb rack or by being dropped from the cockpit.

Fig. 1. Airways Parachute Flare Showing the Open Parachute and Lighting Charge

Camera Obscura

On May 22d, Major W. A. Borden, of the Aberdeen Proving Ground, gave an illustrated talk on the Camera Obscura for bomb testing which has been erected at the Aberdeen Proving Ground, showing the features of its construction and the methods of operation. This camera obscura has been in satisfactory operation and represents the culmination of five years' work to arrange suitable apparatus for the purpose of obtaining ballistic data on bombs. Except for a few slight changes for the purpose of correcting the adjustments of the apparatus, equipment is now complete, and it is expected to work throughout the summer in obtaining data for standard bombs with a view of constructing suitable range tables.

Explosives for Hand Grenades

As the explosive used during the War in hand grenades was extremely hygroscopic, and badly corroded certain parts of the hand grenade, development work has been proceeding to obtain an explosive more satisfactory for use in hand grenades. TNT is not hygroscopic but has too great brisance, pulverizing the cast iron body of the grenade instead of breaking it up into appreciable fragments. There have recently been developed two grenade powders —P. A. Grenade Powder and Hercules Grenade Powder— and these have been tested in hand grenades with fairly satisfactory results. Further tests will be carried out by the using Services to confirm, if possible, the results obtained, and surveillance tests will also be carried out to ascertain the storage qualities of these two new types of powders.

Powder Time Fuzes

Stocks of powder time fuzes remaining after the War were sufficiently large to make unnecessary for some years any manufacture of this type of fuze. It was feared, however, that the art of manufacturing these fuzes would die if some work was not done. Picatinny Arsenal has loaded powder time fuzes and these were recently tested at the Aberdeen Proving Ground with results equal to those obtained with the best product of the War. These tests warrant manufacture on a production basis.

Dummy Charges for 16-inch Gun, Mod. 1919 and 16-inch Howitzer, Mod. 1920

Dummy charges for the 16-inch Gun, Model 1919, and the 16-inch Howitzer, Model 1920, have been developed at the Rock Island Arsenal and one of each has been manufactured. These dummy charges will be shipped to the coast defenses where they will be examined and tested; if found satisfactory, additional charges of both types will be made.

Elimination of Use of Loose Black Powder by the Using Services

Black Powder being susceptible to explosion by friction, is a dangerous explosive to handle, and serious accidents have occurred in the using Services due to its use, particularly with regard to saluting charges and to charges for the Pole type smoke puff outfit. An effort is being made to supply made-up charges instead of issuing bulk powder. The saluting charges for the 37-mm. and 75-mm. guns have been developed and tested with satisfactory results, and an attempt will be made to supply the necessary number of these charges for saluting purposes. The cloth used in the manufacture of these bags is a light weight muslin of the best commercial quality, but low grade cartridge cloth

may be used for the purpose until such stocks of this low grade cartridge cloth which are on hand are exhausted. In order to save the cost of transportation of black powder to Picatinny Arsenal, it is probable that bags for saluting charges will be made at Picatinny Arsenal and shipped for loading to the Field Service depot at which the black powder is stored.

Charges for the Pole type smoke puff outfit have been developed and found satisfactory at the Aberdeen Proving Ground and by the Field Artillery School. These charges are made up in small paper cartons, the top of which can be punctured, and the carton upturned for loading into the smoke puff outfit. A mixture of Grade A-1 and Grade A-4 black powders is used so that there may be some fine black powder present to run down into the flash hole of the discharger, thereby assuring the ignition of the charge. The old name "Pole Type Smoke Bomb Outfit" is now "Pole Type Smoke Puff Outfit" as the policy has been established to limit the use of the word "bomb" to aircraft matériel.

ARTILLERY DIVISION

3-inch Antiaircraft Gun Mount, Model 1923 E

The Gun Mount shown in Fig. 2 is designed as a mobile antiaircraft gun trailer mount. The trailer is a modified 3-inch field gun trailer strengthened to carry the heavier load and provided with outriggers for firing. The outriggers and deck are so arranged that they may be readily folded up for transportation.

The gun has a muzzle velocity of 2,600 f. s. and is provided with a semi-automatic side sliding breech mechanism. A closing spring is provided which operates to close the block when the extractors are tripped. On counter-recoil the block is opened by a cam so that when the gun is returned to battery the block is open and the empty case has been ejected.

The loading tray is mounted on the left side of the cradle in line with the fuze setter, and is so pivoted that it can be swung into line with the bore for loading. Ramming is accomplished by a hand-operated cable device. The cable is run through pulleys so that the pull may be exerted in any convenient direction. The block on closing pushes the tray clear of the gun. A safety device is provided so that the firing handle cannot be operated until the tray is entirely clear of the gun.

Double handwheels are provided for both the elevating and traversing mechanism for easy operation. In addition, two speeds are provided for both sets of mechanisms and the traversing mechanism has a clutch which may be thrown out to traverse the mount by hand. Since the trunnions are near the breech, equilibrators are necessary, and equilibrators of the pneumatic type have been provided to balance the tipping parts. The handwheel loads for this type of mount are very light and both the elevating and traversing mechanism operate very easily.

The mount has a leveling device of the hemispherical type operated by a nut and cross screws working on the pintle of the top carriage, which permits of levelling the carriage 5 degrees in either direction.

The mount is designed primarily for indirect fire using the deflection and elevation given from a central fire control station. An emergency sighting system is provided on the mount, however. On the left side of the mount a telescope is provided for direction. The motion of the telescope in laying on the target in direction is transmitted to a disc in front of the cannoneer operating the traversing handwheel. Having set the initial correction on his scales he then completes the laying of the piece by keeping the two indices together.

A drum connected to the right trunnion of the piece is so arranged that the cannoneer operating the elevation handwheel lays the gun in elevation by keeping the pointer on the elevation curve being used. The changes in setting in altitude are made by a second cannoneer. The gun and mount weigh 4,300 pounds, and the total weight, including the trailer, is 11,600 pounds. The pilot material has been completed and is now at Aberdeen Proving Ground undergoing test.

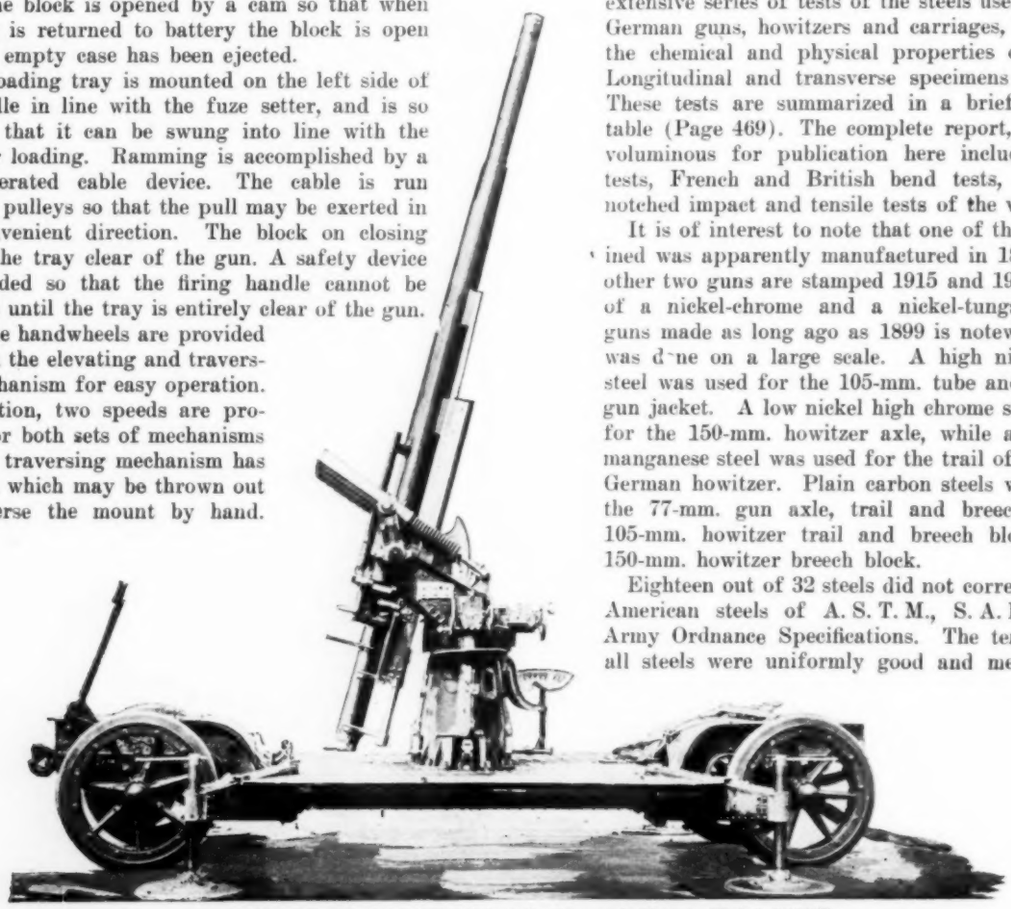


Fig. 2. The 3-inch Antiaircraft Gun and Mount, Model 1923 E

Summary of the Investigation of Steels Used in German Ordnance

Recently the Ordnance Department conducted an extensive series of tests of the steels used in different German guns, howitzers and carriages, to determine the chemical and physical properties of the steels. Longitudinal and transverse specimens were tested. These tests are summarized in a brief way in the table (Page 469). The complete report, which is too voluminous for publication here included hardness tests, French and British bend tests, and Charpy notched impact and tensile tests of the various steels.

It is of interest to note that one of the guns examined was apparently manufactured in 1899 while the other two guns are stamped 1915 and 1918. The use of a nickel-chrome and a nickel-tungsten steel in guns made as long ago as 1899 is noteworthy if this was done on a large scale. A high nickel-tungsten steel was used for the 105-mm. tube and the 77-mm. gun jacket. A low nickel high chrome steel was used for the 150-mm. howitzer axle, while a silico-nickel manganese steel was used for the trail of the 150-mm. German howitzer. Plain carbon steels were used for the 77-mm. gun axle, trail and breech block, the 105-mm. howitzer trail and breech block, and the 150-mm. howitzer breech block.

Eighteen out of 32 steels did not correspond to any American steels of A. S. T. M., S. A. E. or U. S. Army Ordnance Specifications. The tensile tests of all steels were uniformly good and meet the U. S.

ANALYSIS OF THE STEELS USED IN GERMAN ORDNANCE

77 mm. Gun Manufactured in 1915.
105 mm. How. Manufactured in 1899.
150 mm. How. Manufactured in 1918.

Component of Gun or Carriage	CHEMICAL ANALYSIS (C) C.	Mn.	P.	S.	Si.	Ni.	Cr.	W.		PHYSICAL PROPERTIES Elastic Limit Trans.	Elastic Limit Long'tl.	Yield Point Transverse	Ultimate Transverse	PER CENT OF Elongation Transverse	Reduction of Area Transverse	Charpy Notched Ft.-Lbs. Transverse
Tube of 77 mm. Gun	.31	.26	.029	.041	.203	2.81	.99	....	A	60,000	65,000	78,000	103,000	25	60	22.5
" " 105 mm. How.	.29	.32	.024	.015	.225	5.55	.11	.60	B	50,000	70,000	88,000	113,000	17	53	26.8
" " 150 mm. How.	.44	.22	.022	.043	.228	2.78	1.29	....	C	65,000	69,000	77,000	102,000	24	47	18.2
Jacket of 77 mm. Gun	.21	.35	.022	.014	.183	5.73	.02	.42	D	63,000	64,000	73,000	98,000	24	51	19.5
" " 105 mm. How.	.51	.21	.010	.033	.260	3.12	1.5	....	E	61,000	67,000	74,000	107,000	20	49	21.4
" " 150 mm. How.	.34	.28	.036	.059	.250	2.67	1.21	....	F	65,000	63,000	75,000	99,000	22	44	17.4
Muzzle Hoop 77 mm. Gun	.49	.23	.013	.033	.205	3.18	1.36	....	G	.....	53,000	77,000*	100,000*	25*	62*	37.5*
" " 105 mm. How.	.38	.24	.025	.033	.220	2.97	1.42	....	H	.....	.....	94,000	115,000	25	53	30
" " 150 mm. How.	.42	.22	.009	.031	.195	3.04	1.38	....	I	.....	51,000	67,000*	104,000*	18*	58*	30.9
Center Hoop 77 mm. Gun	.48	.29	.020	.039	.208	2.64	1.55	....	J	.....	70,000	76,000*	100,000*	18*	38*	16.9*
" " 105 mm. How.	.48	.26	.029	.039	.253	3.18	1.43	....	K	.....	74,000	87,000	101,000	21	50	17.8
" " 150 mm. How.	.39	.22	.036	.060	.298	2.69	1.23	....	L	.....	63,500	75,000*	102,000*	20*	64*	29
Locking Hoop 77 mm. Gun	.47	.26	.014	.034	.218	3.01	1.35	....	M	.....	.....	93,000*	112,000*	16*	52*	
" " 105 mm. How.	.45	.25	.018	.027	.170	2.55	1.42	....	N	.....	.....	76,000*	102,000*	29*	62*	43.2*
" " 150 mm. How.	.47	.24	.028	.033	.148	2.68	1.53	....	O	57,000	56,000	66,000	94,000	28	57	26.4
Breech Block 77 mm. Gun	.67	.42	.022	.033	.231	....	.06	....	P	57,000	60,000	70,000	112,000	21	40	4.9
" " 105 mm. How.	.65	.40	.022	.028	.195	....	.06	....	Q	.....	.....	68,000	103,000	14	22	6.9
" " 150 mm. How.	.69	.27	.026	.038	.245	....	.05	....	R	51,000	55,000	58,000	103,000	18	32	2.7
Axles 77 mm. Gun	.49	.86	.040	.033	.285	.27	.07	....	S	.....	.....	79,000*	112,000*	24*	43*	3.7*
" 105 mm. How.	.40	1.82	.026	.018	.105	.32	.16	....	T	.....	69,000	76,000*	101,000*	23*	66*	37.4*
" 150 mm. How.	.37	.30	.043	.044	.155	1.16	1.57	....	U	.....	70,000	76,000*	98,000*	24*	62*	27
Trail 77 mm. Gun	.35	.61	.059	.035	.140	.07	....	....	V	.....	52,000	61,000*	88,000*	13*	22*	* Longitudinal
" 105 mm. How.	.46	.81	.021	.029	.230	.07	....	....	W	.....	51,000	55,000*	89,000*	11*	40*	
" 150 mm. How.	.49	1.68	.019	.018	.610	2.23	.14	....	X	.....	74,500	88,000*	106,000*	6*	32*	

Army Ordnance specifications for like steels. As a whole the tests indicate a somewhat greater uniformity in the steel of the pre-war German guns.

The Charpy notched impact test values on the larger gun forgings, such as tubes, jackets and hoops, were in the aggregate very good, and the heat treatment was evidently adjusted to obtain good Charpy values.

Mechanical Loader for 4.7-inch Antiaircraft Gun Mount, Model 1920 E

A mechanical loader is being manufactured at Rock Island Arsenal for the 4.7-inch Antiaircraft Gun Mount, Model 1920 E. This mount is now at the Aberdeen Proving Ground where it has undergone an extensive proof-firing test.

A mechanical loader for an antiaircraft mount of this caliber is essential if a high rate of fire is to be obtained. The round for this gun weighs 70 pounds and is 42.5 inches long, and must be loaded at all angles between 5 degrees depression and 80 degrees elevation and at any angle of traverse.

The mount was originally equipped with a pneumatic loading mechanism which depended upon a gasoline motor-driven air-compressor for the air, but this loader proved unsatisfactory as it used considerable air, necessitating a large reservoir and the continuous pumping by the motor during firing, all of which were undesirable on a mobile mount.

The object of the new loader is to load the gun by the energy of recoil.

This mechanism consists of two essential units, the spring cylinder for storing the energy taken from the gun in recoil, and the tray which contains the gearing and a support for the round. The spring rod contains a buffer for controlling the speed of the round when ramming.

The tray is mounted convenient to the breech and swings about an axis parallel to the bore. In the "off" position the tray is in line with the fuse setter, and when swung in line with the bore the round comes in front of the rammer head.

When the ramming spring is tripped, the rammer "A" runs forward carrying the round with it. When the round has travelled about half its distance, the rammer picks up a two-to-one gear mechanism in the tray. This mechanism consists of a spur gear "B," a fixed rack "C," and a movable rack "D." A pawl on the front end of the movable rack engages the round and carries it the last half of the way. The rammer drives the gear mechanism through the spur gear shown in Fig. 3. The fixed rack causes the gear to turn while it is being advanced, thereby driving the

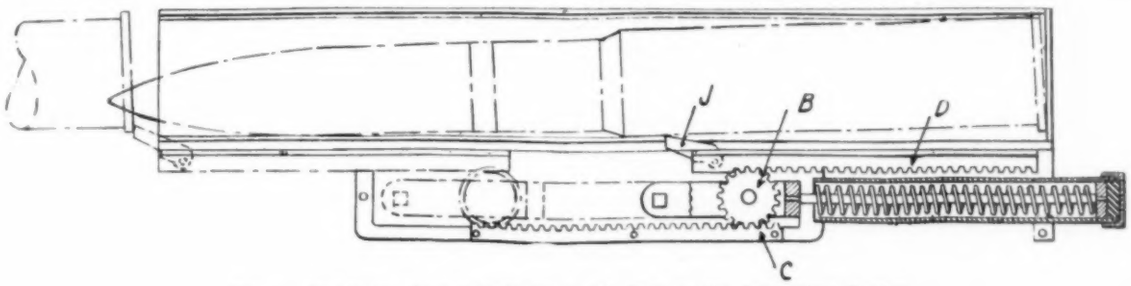


Fig. 3. Two-to-one Gear Mechanism in the Tray of the Mechanical Loader

movable rack twice the distance travelled by the gear.

The two-to-one gear mechanism is made necessary by the variable length of recoil of the gun (30 to 60 inches) and by the construction of the gun itself which requires

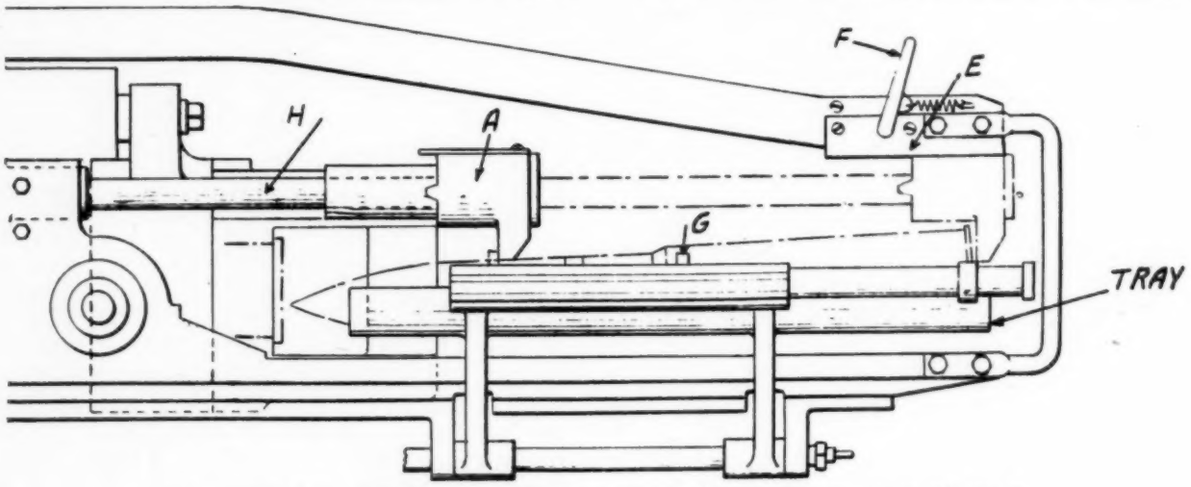


Fig. 4. Sketch of the Mechanical Loader for 4.7-inch Antiaircraft Gun Mount, Model 1920 E

that the rammer follow the round up inside the breech.

The seating of the round trips the breech block closing spring which in closing the block throws the tray to the fuse setting position. At the same time a spring in the tray returns the two-to-one gear to its initial position.

The pull on the spring cylinder is given to the mount through a bracket fastened to the forward end of the left side cradle plate. The outline of the tray and tray arms are similar to the parts now used on this mount.

Fig. 4 shows a side view of the mount with the tray in line with the bore. On long recoil the rammer "A" goes a considerable distance beyond the round, but it is retarded on its return by the oil buffer in the spring rod "H" until it is stopped by a catch in bracket "E."

Tripping the lever "F" allows the rammer to move forward carrying the round until it picks up the lug "G" of the two-to-one gear mechanism. At this point the pawl "J" comes up in back of the round and from here on the gearing carries the round on until it is seated in the bore. It will be noticed in this figure that the rammer "A" stops about 10 inches from the seated position of the round.

INFANTRY AND AIRCRAFT ARMAMENT DIVISION

The Improved Colt .45 Pistol

The Colt Automatic Pistol, Model of 1911 was adopted as a result of comparative tests in 1911 to replace the caliber .45 revolver. The behavior of this weapon has been such as to justify the judgment of the Board in recommending its adoption. It is a dependable weapon and stands up well, considering the rough usage to which it is subjected.

Naturally, there have been criticisms of this weapon, but in the majority of cases it has been found that the criticisms were not well founded. Some of the objections raised, however, have been pertinent, and an effort has been made to meet them. The most important of these is the fact that when the average man attempts to fire the weapon at an object, as one wuold point the index finger, the bullet almost invariably goes low. The angle between the grip and the bore is apparently too acute to fit the average man's hand. Another point brought out is the fact that with many men the fleshy part of the hand between the thumb and forefinger is pinched between the hammer and tang of the grip safety when the slide recoils. It is difficult for a man with a small hand to pull the trigger properly, due to the fact that the trigger projects

Ordnance Stores Control

(Continued from page 435)

and later furnishes shipping instructions to the Manufacturing Service, if in peace time or to the District Offices if the latter are operating. Field Service must be notified by the Manufacturing Service the dates of completion of the articles in order that shipping instructions may be furnished prior to the dates of completion of the supplies.

The following is a brief discussion of how the control of stores is operated by the Commanding Generals of troops.

Allowances of supplies to be under the supervision of Commanders of Troops are prescribed for tactical organizations by Basic Tables of Allowances and for station and area depots in the Zone of the Interior by special instructions of the War Department. For depots in the Theatre of Operations they are prescribed by the Commanding General thereof on approval of the War Department. Station depots are authorized Class I, II and III supplies sufficient to meet the needs of the troops for a period of from one to three months as determined by the Corps Area Commander. Stocks of Class IV supplies are prescribed by the Chiefs of the supply branches on recommendation of Corps Area Commanders. Area depots are authorized Class I, II, and III supplies for three months' consumption and Class IV supplies as prescribed by the Chiefs of supply branches. The above allowances are prescribed in letter of The Adjutant General of the Army on the subject of Organization and Operation of Storage Depots in the Zone of the Interior dated January 15, 1921, file AG 681 (Pub. Div.) file 00 633/695. The above-mentioned letter states that the stocks to be maintained in the foreign possessions will be in such quantities as may be designated by the Secretary of War but as yet no allowances have been prescribed and it is, therefore, left to the judgment of the Commanding Generals of the possessions and the Chiefs of supply branches in Washington.

Author's Note.—In the preparation of the above article free use was made of the report of the "Control Committee," Office of the Chief of Ordnance, prepared by Majors W. B. Hardigg, G. P. Wilhelm and the author.

forward so far. With the standard gun, the trigger is usually pulled with the first joint of the finger on it. Also the front sight is rather narrow for use in all conditions of light.

To remedy these defects, an improved model of the Colt Automatic Pistol, Model of 1911, has been approved by the Ordnance Department. Several of the modifications made were suggested by the Cavalry. A number of these improved pistols were made up and tested by the Cavalry Board at Fort Riley, and a very favorable report submitted. A few were exhibited at the National Matches last year and excited very favorable comment by the pistol shots assembled there.

A picture of the new pistol appears on this page. The most important change is bringing the mainspring housing to the rear, making a sort of hump, which fits into the soft part of the palm of the hand, and has the effect of not only giving a better grip on the pistol, but tips the barrel up so that the shooter instinctively points toward the object he wishes to hit. The mainspring housing has also been checked to prevent slipping when the hand is moist. The tang of the grip safety has been brought to the rear, so that it fits over the portion of the hand between the thumb and forefinger and prevents pinching the skin when the slide recoils. The trigger itself has been cut back approximately one-quarter inch, and the sides of the receiver, just back of the trigger, cut away. This enables the average shooter to grip the trigger with the second joint of his forefinger without assuming a strained position. The front of the trigger has also been checked to afford a better grip. The width of the top of the front sight has been increased from .038-inch to .058-inch. This width front sight has been placed on National Match pistols for the past four years, but has now been adopted as the standard sight for all future manufacture.

Another change has been made which cannot be shown in the picture. Our tests show that the accuracy of the pistol is improved when the bullet has a slightly tighter fit in the bore than at present. Last year, to accomplish this, the special caliber .45 National Match ammunition was made .0005-inch larger in diameter than the standard ammunition. In the new pistols, we are accomplishing this result by reducing the maximum land diameter by .002-inch and increasing the depth of the grooves .0005-inch.—(Major LEE O. WRIGHT, Chief, Infantry and Aircraft Armament Division, in *The American Rifleman*, May 1, 1924.)

PICATINNY ARSENAL

ELECTROCHEMICAL CORROSION OF ALUMINUM FUZE SEAT LINERS

Many of the recently designed projectiles that are fitted with an internal fuze have an aluminum fuze seat liner inserted in the fuze cavity. The function of this liner is to hold the explosive D in place in the shell and to keep the explosive clean and dry. These liners are made of aluminum because it has been found that this metal is not attacked by Explosive D.

A number of unusual cases of corrosion of fuze seat liners have recently been encountered. An extreme case of corrosion of this nature was found at Fort Drum, P. I., where upon inspecting 6-inch projectiles, a badly corroded liner was taken from one of the shells. The exact length of time that this fuze seat liner had been in the shell was not known, but it was believed to have been not over six weeks. In this short time the corrosion had proceeded so far that the metal was eaten entirely through in places and portions of it had been reduced practically to a powder.

This corroded fuze seat liner and a sample of the Explosive D taken from around the fuze seat cavity of the shell in question were sent to Picatinny Arsenal for examination and analysis in order to determine the cause of the corrosion.

By analysis, the uncorroded part of the liner was found to be aluminum, containing a small amount of iron and

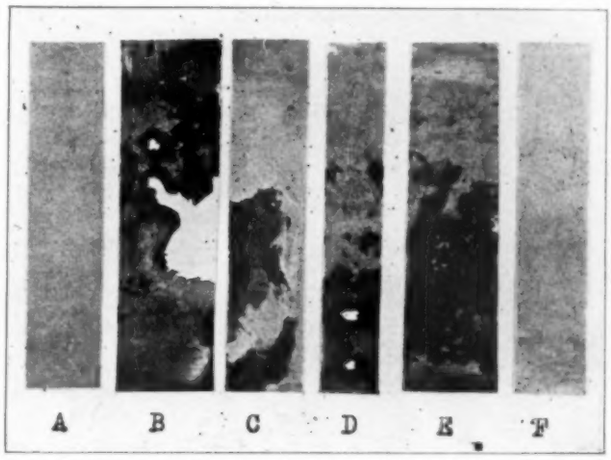


Fig. 5. Electro-chemical Corrosion of Aluminum

A—Aluminum strip before test.
B—Aluminum strip after 45 days' contact with steel at 50 degrees C. in Explosive D as received from Manila.
C—Slight corrosion of aluminum strip after storage for 30 days at 50 degrees C. in Explosive D received from Manila, with 2 per cent distilled water added.
D—Corrosion after contact with steel for 20 days at 50 degrees C. in Explosive D from Manila, with 2 per cent distilled water added.
E—Aluminum strip after 45 days' contact with steel at 50 degrees C. in pure Explosive D, with 2 per cent distilled water added.
F—Aluminum strip stored alone for 30 days at 50 degrees C. in Explosive D as received from Manila.

silicon, indicating that the metal used in the liner was of the ordinary commercial grade. The corrosion products which were removed from the liner in abundance consisted of particles of aluminum and aluminum oxide and a small amount of aluminum chloride.

The Explosive D taken from around the fuze seat cavity contained no acid, alkali, or other corrosive substance. Except for the fact that it was dark in color and that it contained an excess of insoluble material which was identified as grease and iron oxide, the Explosive D complied with specifications for that material.

The cause of the corrosion therefore could not be determined definitely from an examination and an analysis of the liner and the Explosive D, neither could it be attributed simply to the chemical action of the Explosive D on the liner for no instance of a reaction between Explosive D and aluminum is known. Since it was only reasonable to assume that special conditions had given rise to the corrosion and yet nothing of an unusual nature was found in either the explosive or the metal of the liner, it became necessary to look further for the source of the action.

The danger of corrosion due to having two dissimilar metals in contact is well known, and it was considered possible that the corrosion of the fuze seat liner was caused by electrochemical action due to having the aluminum liner in contact with the iron base plug of the shell. The following experiments were therefore performed in order to determine if such might be the case.

A strip of aluminum metal placed in contact with a strip of iron and tied with an iron wire to secure good contact

was immersed in the Explosive D taken from the shell in which the corrosion of the fuze seat liner had occurred. The Explosive D was moistened with 2 per cent distilled water and kept at a uniform temperature of 50° C. In about twenty days, the strip of aluminum was corroded in a manner similar to that of the aluminum fuze seat liner; in fact the action had been so pronounced that the metal strip could be broken readily into small pieces with the fingers. This corrosion was practically the same on the side of the aluminum strip that was not in contact with the iron as on the side that was in contact. Using aluminum alone, instead of iron and aluminum as in the previous experiment, no corrosion was found after fifty days.

Corrosion of the aluminum also occurred in about forty-five days when a similar experiment was carried out in which iron and aluminum were immersed in the same sample of Explosive D, except that no moisture was added. Photographs of the various specimens are shown in Fig. 5.

Other similar experiments were also performed with chemically pure Explosive D. The same results were obtained in these experiments, except in the test where iron and aluminum were immersed in pure dry Explosive D. No corrosion of the aluminum was found in this test after sixty days, the difference no doubt being due to the absence of moisture.

The above experiments show conclusively the danger of electrochemical corrosion due to the presence of iron and aluminum in contact in Explosive D. This electrochemical action is accelerated by the presence of electrolytes and moisture in the explosive.

WATERVLIET ARSENAL

Relining 14-Inch Guns

There are in service a number of 14-inch wire-wrapped guns designated as Models of 1910 and 1910 MI. The essential difference in the guns is that the material of the "B" tube and jacket in those of the 1910 model is known as "gun steel," having elastic limits of 46,000 and 48,000 pounds per square inch respectively, while the same elements in the 1910 MI models are an alloy steel of 55,000 and 60,000 pounds per square inch. Guns Nos. 1 to 13 are Model 1910 and differ slightly from guns No. 14 and above, which are Model 1910 MI.

All these guns were constructed by first assembling the "B" tube upon the "A" tube, or liner, next winding the wire, and then, as the final operation, the jacket and hoops were assembled over the wire.

This method of construction gives the greatest possible initial compression to the interior of the "A" tube, because the deformation at the interior element is the sum of the relative compressions of all the members surrounding it, while in a gun having the "A" tube, or liner, assembled last, the compression at the bore is only that caused by the shrinkage used at the exterior surface of this member.

At a section through the powder chamber the interior of the "A" tube has a compression of approximately 46,000 pounds per square inch, which is the elastic limit of the material in tension.

When the attempt was made to remove the liner from gun No. 1, it was found that the temperature of 400° F. was not high enough, so the temperature was increased to 750°, which was just sufficient to allow its removal.

The interior diameter of the "B" tube was then accurately measured and the results checked with the calculated compression that would be caused by the enveloping wire, jacket, and hoops. It was found that practically no compression existed. It is thought that the temperature necessary to remove the liner had destroyed a large percentage of the tension in the wire. Previous tests at Watertown Arsenal showed that a permanent set of a certain amount would occur when the wire was heated under tension to considerably lower temperatures than 750°. For this reason it has been decided that temperatures above 400° are detrimental to the wire, and will not be used in relining this type of gun.

This gun was relined with a very light shrinkage, when the caliber is taken into consideration, as it was thought that the pressure in action on the interior of the "B" tube should be made as low as possible.

During the test of Gun No. 1 at the Aberdeen Proving Ground an expansion occurred in the maximum pressure sections, but ceased after a few preliminary rounds.

When this gun is returned for its second relining, it will be interesting to investigate the interior diameters of the "B" tube, after the removal of the "A" tube or liner, to determine whether any permanent deformation has occurred.

When Gun No. 13 was relined, it was decided to remove the "A" tube by boring and thus eliminate any possibility of removing the compression due to the wire by the temperature necessary for this operation.

Calculations were made in the Ordnance Office as to the compression that should be found at the interior element of the "B" tube after removal of the "A" tube or liner. The comparison of the actual compression (see table) with the calculated compression, while not exactly agreeing, was thought to be very good when the firing stresses to which the material in a cannon are subjected in action are taken into consideration.

The shrinkage between the "A" and "B" tubes in Gun No. 13 on relining was greater than that used in Gun No. 1 for the reason that the "B" tube in Gun No. 13 showed an appreciable amount of compression at the bore, and it was thought that a certain percentage of the firing stresses could be safely taken up by this member. The action of the liner in this gun will be discussed when more data are available.

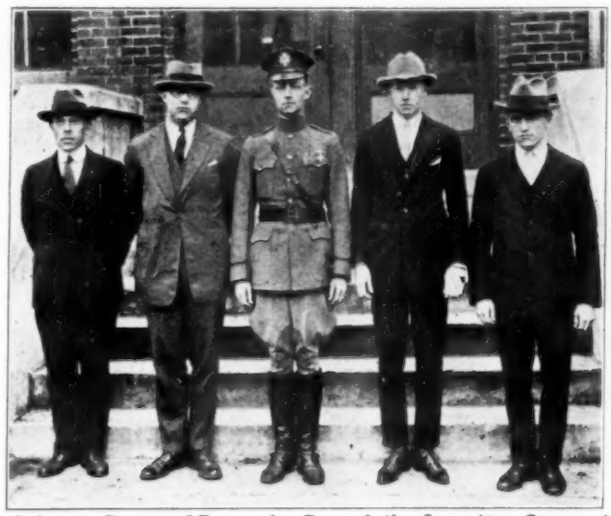
The relining of Gun No. 18, Model of 1910 MI, will soon be completed and forwarded to the Proving Ground for test. The actual compression of the interior of the "B" tube of this gun after removal of the liner was very close to the calculated value at a section through the powder chamber so a shrinkage close to that used in Gun No. 13 was decided upon and for the same reason as that shown for Gun No. 13. The method of removing this liner was described in a recent issue of this journal. (See Army Ordnance, Vol. IV, No. 19, July-August, 1923, Page 58.)

14-in. Gun Number	Results	Compression of Bore Measurements Taken From Breech End 30-in.	171-in.	211-in.	311-in.	361-in.	411-in.	461-in.	511-in.	541-in.
1	ACT.	.0045	.0045	.0045	.0030	.0035	.0030	.0030	.0032	.0035
	CAL.	.0039	.0033	.0033	.0025	.0033	.0031	.0032	.0031	.0032
13	ACT.	.0115	.0065	.0060	.0060	.0045	.0040	.0030	.0030	.0030
	CAL.	.0156	.0120	.0113	.0100	.0093	.0081	.0076	.0067	.0064
	ACT.	.0140	.0100	.0095	.0080	.0075	.0050	.0060	.0060	.0060
18	CAL.	.0141	.0101	.0099	.0090	.0086	.0078	.0073	.0070	.0067
	CAL.	.0051	.0018	.0049	.0055	.0068	.0066	.0058	.0056	.0057

Actual and Anticipated Bore Compressions on Relining 14-inch Guns, Models 1910 and 1910 MI

Reserve Corps Notes

THE second two weeks' training course for Rseerve Officers of the Ordnance Department at Springfield Armory was given from May 12th to May 24th. Four officers assigned to the Bridgeport District Ordnance Office were on active duty during this training period and received training which covered manufacture at the Government arsenal, duties in connection with the District Office and manufacturing on Government work at a commercial plant. A number of very interesting and instructive lectures were given covering matters of interest to officers who would act as inspectors or production officers in an emergency.



Ordnance Reserve Officers who Pursued the Inspection Course at Springfield Armory, May 12 to 24, 1924

Left to right: Capt. Stanley Dewsnap, 1st Lieut. Ernest F. Bessette, Lieutenant D. G. McGregor, Ord. Dept., U. S. A., Executive Officer, Bridgeport District Ordnance Office, 2nd Lieut. Harry P. Croft, and 2nd Lieut. Gilbert I. Ross.

The first part of the course was devoted to the manufacture of the Springfield Rifle, starting with a preliminary discussion and continuing the periods in the shops devoted to the various manufacturing processes including periods in the laboratory and experimental department. A part of the course was devoted to actual gaging operations by the students and a study of the gaging methods in general and the gage storage for the various kinds of small arms.

A trip to the Colt's Patent Fire Arms Mfg. Co. in Hartford was arranged, the students visiting all departments of the plant and then being placed under the Government inspector to study his methods of operation and to observe the procedure of the Government inspector in a commercial plant.

One day was assigned for work in the Bridgeport District Ordnance Office. The students were shown what was necessary in the peace time operation of the office and what would be necessary in time of war. An outline was given showing the work accomplished by the various Ordnance Districts during the first year and a half of operation. A problem was assigned covering a typical case of the preparation of a factory war plan by commercial plants. This problem was solved by the students to acquaint them with requirements in machine tools, raw materials, etc., necessary for the commercial plant to produce a given article. The time factors and sources of supply were studied and all the necessary schedules and forms made out in order to give the students a clear idea of the problem involved in war production and preparation. It was felt that this problem was of great value in showing the Reserve Officers what definite steps are necessary in the industrial preparedness plan and in the operation of the districts. It is believed that typical problems of this nature could be incorporated into a correspondence course for Reserve Officers assigned to districts and that great advantage to the officers and to the Government would result in the solving of such problems. The following officers were on active duty for the duration of the course. Capt. Stanley Dewsnap, 54 Westford Circle, Springfield, Mass.; 1st Lieut. Ernest F. Bessette, 76 Arnold St., Hartford, Conn.; 2nd Lieut. Harry P. Croft, 19 Farnham Ave., Waterbury, Conn.; 2nd Lieut. Gilbert I. Ross, 1488 Yale Station, New Haven, Conn.

Lieut. D. G. McGregor, Executive Assistant of the Bridgeport District Ordnance Office acted as Executive Officer for the course.

The interest manifested by all officers taking the course and the information gained by them shows that these courses will prove of great value in the building up and training of the Ordnance Reserve Corps.

The War Department has made provisions for the training of Reserve Officers of the Branch Assignment Group during the fiscal year 1925, by Chiefs of Branches. In the past no provisions were made for this training, except for a limited number of officers assigned to procurement duty, other than at corps area camps. The Ordnance Department plans to conduct camps this year to train approximately 150 Reserve Officers at Aberdeen Proving Ground, Md., and Rock Island Arsenal, Ill.

It is planned that those Reserve Officers who have not been called to active duty, for training, since the war, or who have not attended any training camp since being commissioned in the Reserve Corps, will pursue a general course of instruction covering all the activities of the Ordnance Department. The purpose of this training is to familiarize the officer with the mission of the department, its duties and responsibilities, its organization for the execution of its mission, and the relation the several activities bear to each other. The training to be conducted at each of the two estbalishments will, in addition to the foregoing, cover the current activities of the establishments.

The second and successive calls to active duty for training will be spent at the particular arsenal, depot, proving ground, district or office to which the officer is assigned

under the mobilization plan. In general, this training will be in the specific duties called for by his war assignment.

The two general courses this year will be held during the period August 3 to 17, inclusive. As mileage is a controlling factor, attendance at Aberdeen Proving Ground will be limited to those officers residing within the 1st, 2nd, 3rd and the northeastern part of the 4th Corps Areas, and at Rock Island Arsenal to those residing within the 5th, 6th, 7th and the northwestern part of the 4th Corps Area.

Procurement District Training Courses

The Ordnance Department has just completed three training courses for Ordnance Reserve Officers assigned to procurement districts. The reserve officers pursued a general course of instruction to fit them for duties as inspectors in commercial plants manufacturing ordnance.

The following officers were on active duty at Rock Island Arsenal May 12th to 24th, inclusive:

Maj. Harold McGeorge, Capt. Robt. W. Blair, Capt. Michael H. Ellison, Capt. Henry Swift, Capt. Oscar H. Wurster, 1st Lt. Victor Fabian, 1st Lt. Wm. A. Fay, 1st Lt. Clifton R. Hovland, 2nd Lt. Fred Hanss, 2nd Lt. Louis H. Hibbetts, 2nd Lt. Paul E. Holcomb, 2nd Lt. Robt. B. Lewis, 2nd Lt. Louis E. Limbert, 2nd Lt. Henry T. Protherio, 2nd Lt. Robt. K. Sharp.

The following Ordnance Reserve Officers were at Frankford Arsenal May 12th to 24th, inclusive:

Capt. Robt. B. Cable, Jr., Capt. Chas. B. Mellen, Capt. Joseph D. Murray, 1st Lt. Chas. A. Brace, 1st Lt. Clay M. Fooks, 2nd Lt. Kelsey H. Jewett.

New Ordnance Reserve Officers

The following have recently accepted commissions in the Ordnance Officers' Reserve Corps:

Colonel: Christian G. Storm. Lieut. Colonels: Basil Middleton, Charles F. Park. Majors: John B. Elmendorf, Alva E. Garey, Aldridge E. Hunt, Johnson Morgan. Captains: Walter Arthur, Herbert Collignon, Arthur W. Coombs, Thomas T. Logie, Edward E. Tanguy, Lester T. Wilson, Clifford G. Woolson, Edward E. Young. First Lieuts.: Walcott D. Bartlett, Levi C. Eddy, Leroy C. Ensminger, Dwight R. Gardner, Kenneth H. Gordon, Morris P. Keith, Moses B. Levin, George H. S. McNair, Earl Naramore, William C. Oleson, Edwin R. Page, Heber A. Sotzin, Jesse A. Sutton. Second Lieuts.: Charles W. Apthorpe, George A. Boyd, Thomas L. Hapgood, William B. Johns, Jr., Fred R. Procise (transferred from infantry), Olen B. Shawhan, Will H. Slater, Richard E. Stutzman.

Reappointments

The following have recently accepted reappointments in the Ordnance Officers' Reserve Corps:

Majors: Walter C. Brown, Horace A. Cate, Roy W. Chandler, Harold H. Clark, William S. Conant, William C. Coryell, Coulter Craig, Carroll H. Gardner, Arthur F. Hebard, Malcolm S. Huey, John M. Morehead, Robert K. Root, Paul H. Schubert, Clinton W. Sells, Eugene J. Sullivan, Herbert B. Trix, Leon C. Van Bever, Robert D. White. Captains: Robert A. Allen, Sydney Bevin, Robert E. Briggs, Daniel L. Britten, Joseph F. Collins, Harry M. Cooley, Stanley Dewsnap, Joseph T. England, William R. Fawcett, Alfred H. Ferrandou, Floyd E. Harris, William W. Hodge, William N. Holmes, Arthur C. Hubbell, Charles J. Jeffers, Adolphus L. Kershaw, Nevins F. Kirkpatrick, Harry C. Lea, Edward F. McCrossin, Archibald McMillan, Glenn E. Mapes, Thomas Reath, Jr., Furman South, Jr., Walter W. Strait, John M. Thomas, Paul F. Titchener, Felix F. Tranchina, Herbert T. Wade, James K. Welsh, William H. Wharton, Harry Whitney, James S. Wiley, William C. Wright, Ralph W. Yardley. First Lieutenants: Eugene H. Allen, William E. Allen, Rea E. Blankenbuehler, Arthur E. Brooks, William E. Brown, Theodore C. Browne, John N. H. Christman, John F. Drennan, John W. Elmes, Benjamin G. Feinburg, Levi W. Hulley, Joshua M. Matthews, Abner C. Olphant, Robert K. Prince, Cyrus K. Rickel, Everett O. Waters, Harry A. Tuke. Second Lieutenants: Harry V. Anderson, Albert G. Bagley, Jr., Orrin W. Beehler, Smith A. Brownlie, Harold S. Cortelyou, John L. Davidson, John A. Dore, Harry W. Dorigan, Armine L. Gracey, Harold H. Jacobs, Harris A. Jennings, George A. Miller, Peter P. O'Hanlon, Albert W. Place, Samuel K. Rindge, Michael J. Shea, Clement C. Smith, Joseph G. Stephenson, Eli C. Stratton.

Colonel Warren Decorated by France

Col. Charles Elliot Warren, Vice-president of the Irving Bank-Columbia Trust Company and Treasurer of the Army Ordnance Association, was recently decorated by the President of France with the Croix de Chevalier de la Legion d'Honneur for services to France during the World War. The decoration was conferred June 25th.

During the World War Colonel Warren served on the staff of General John T. Thompson in the Ordnance Department where he rendered valuable help in the work connected with the manufacture and supply of small arms. Later he served on the staff of Major General O'Ryan, Twenty-seventh Division, A. E. F.

By direction of the President, Colonel Warren was awarded the Distinguished Service Medal for exceptionally meritorious services during the World War. He has also received the Conspicuous Service Cross and the French Medal de la Reconnaissance. Colonel Warren commands the Veteran Corps Artillery, the oldest military organization in the State of New York, and is in command of the 502nd Antiaircraft Regiment of the 12th Army.

Colonel Warren is an ardent advocate of adequate preparedness and his interest and activity in the Army Ordnance Association is in a great measure responsible for continued effectiveness.

Major Maisch to Teach Tactics

Major Alexander W. Maisch, U. S. A. retired, was recently appointed Assistant Professor of Military Science and Tactics in the high schools of Washington, D. C. Until his retirement, Major Maisch served in the Ordnance Department where he filled many important and responsible posts. He was instrumental in establishing local posts of the Army Ordnance Association at New York and in organizing a local section of the Association at the Massachusetts Institute of Technology.

The National Matches of 1924

Instructions relative to the participation of the National Guard in the National Matches of 1924 at Camp Perry, Ohio, have been issued by the Militia Bureau of the War Department.

The activities at Camp Perry this year will be as follows:

September 6 to 13: School of instruction in marksmanship;

September 15 to 24: National Rifle Association Matches;

September 29 to October 2: National Matches;

Teams from the Regular services, the National Guard, Naval Militia, Organized Reserves, Reserve Officers Training Corps, Civilian Military Training Camps, and civilians are now in process of organization. The executive officer of the matches is Lt. Col. M. C. Mumma, Cav. U. S. A., Iowa City, Iowa.

Book Reviews

The Price of Freedom. By Calvin Coolidge. New York: Charles Scribner's Sons. 30 chapters, 407 pages. Price, $2.50.

The nation is constantly faced with many fundamental problems. It is the cardinal duty of the President to deal with these problems. It is, therefore, of primary interest to American citizens to know of what the views of the President consist. His conception of national principles guides in no small measure the destiny of the country as a whole. An opportunity of learning the views of the President on basic principles of society has just been presented by the President himself.

This book consists of a collection of the President's speeches and addresses. Biography, history, education and politics are used as a background for an exposition of national principles. The usual clear-cut, lucid style of the President is evident throughout the whole book. There can be no doubt at the end of each speech or address that the author has explained his point. Therein lies the charm of the President's writing style. He has the happy faculty of stating what he has to say in direct and simple terms and with a minimum of beating about the bush.

The book takes its title from an address delivered before the Sunday Afternoon Club at Evanston, Illinois, in January, 1923. This address is a masterly exposition of the American theory of government, with freedom as the cornerstone. One harks back to the stirring writings of Roosevelt when reading this chapter.

An excellent chance has been presented to get acquainted with the President. We can not all obtain his views first hand on fundamental principles. It is possible, however, to read his book and to feel at the end that the fruit of much thinking on matters of primary importance has been conveyed to us in a simple and direct manner.

Woodrow Wilson: A Character Study. By Robert Edwards Annin. New York: Dodd, Mead and Company, 1924. 404 pages. Price, $2.50.

Francis Bacon, in one of his essays, suggests: "He that seeketh to be eminent among able men hath a great task; but that is ever good for the public. But he that plots to be the only figure among ciphers is the decay of an whole age." Almost every age has produced some men worthy of the name great. Whether or not Woodrow Wilson will be included among those of the present epoch may be in doubt in the minds of many. The foremost characters of the World War must ever be associated with that great struggle, but whether our war President will stand pre-eminent among them is a matter for posterity. And posterity will demand the stern impartiality of facts! The lesser failings will be blurred out by the greater accomplishments; the petty and the human will be hidden by the depth of inspiration and the height of ideal. This has been the norm of history in the past, and only by the past can we judge the future.

The author of this character study makes no attempt at the "life" of his subject; he tells us that his purpose is "merely to give such account of striking incidents in a distinguished career as may aid in throwing light upon character and mentality. The conclusion suggested is that Dr. Wilson was a statesman of high aims and unique talents, whose life work was hindered by a faulty perspective—personal and political."

We fear that the author was swayed rather by a predetermined opinion than by a free and unbiased appraisal of facts. For example, at the very outset (page 3) he characterizes his subject as "a man who cannot be said to have attained final success in any of the four careers which he essayed—law, letters, teaching and politics." And yet he remarks later (page 7), "these qualities made him one of the most successful teachers who ever occupied a chair at Princeton." And again (page 69), "as a teacher he was great." One must ask: What, then, is the measure of final success in teaching? Does it require more than greatness? And are we to understand that a man who became one of the most successful teachers who ever occupied a chair at Princeton has still a long journey before he achieves final success in teaching?

The author gives a vivid description of the former President's activities at Princeton, as teacher and President, which shed some light on the idiocyneracies of his nature; but there are many instances throughout the book which convince one that the author was not of the Wilson followers, and hence could see little good in most of his undertakings.

The presence of this attitude becomes so obvious at times as to greatly mar the value of the book. For example, on page 339, the author goes out of his way to criticize a phrase used by Mr. Wilson in the preface to one of his works, "Division and Reunion," written thirty years ago. The phrase—well known to all who have read the book—is, "I cannot at all time pretend to have judged correctly as between parties, but impartiality at least I can claim; for impartiality is a matter of the heart, and I know with what purpose I have written." About this Dr. Annin asks: "It reads smoothly, but *is* impartiality a matter of the heart? Is it not rather an attitude of the mind? * * * This is an excellent example of Dr. Wilson's occasional failure to distinguish between phrases and facts." At which the gods smile and wonder that a conscientious character analyst should stoop to such extremes.

There is much in the book that makes it of meager historical value. Were the author's animus better hidden the volume might some day help the historian to know the real Wilson. As it is, his faint praise is too forced and criticism—often puerile—is too much delighted in. Mountains are made of mole hills, and even some facts—for instance imputing the blame upon the President for not allowing General Wood to take his division to France—are not brought forth in their proper light. Wilson's road to greatness in history may or may not be difficult. One way or the other, this book will neither add to nor detract from it.

Democracy and Leadership. By Irving Babbitt. Boston: Houghton Mifflin Company. 349 pages, indexed. Price, $3.00.

To those unacquainted with the works of Irving Babbitt, it may be said as a matter of introduction that he is a profound thinker—one who looks into the future and by a careful analysis of the past and present points out the dangers of modern tendencies. This particular book, though complete in itself, is only one of a series in which the economic, the political, the philosophical, as well as the religious problems of the age are discussed in their relation to the individual and nation. The treatise in its main aspects goes back as far as the Renaissance. Scholars and leaders of thought of all ages are freely quoted.

Democracy, in the opinion of Professor Babbitt, will have to be judged by its leadership. Given the right kind of leadership it will endure. In America, he feels, we are "creatures of habit" and unless we are awakened to a higher ethical standard we are in danger of drifting into a decadent imperialism. Here is where leadership is so important and choice a weighty factor. Circumstances may arise where we would be fortunate if we get the American equivalent of a Mussolini in order to be saved from the American equivalent of Lenin. Laws are of little use unless there is a desire to obey, a desire which is developed primarily through habit and education. In other words, as Aristotle has said—habit must precede reason.

The book should not be confused with the many books written on democracy, which are of the popular type and are for the greater part political propaganda. It is a book for students and one which will stand re-reading and study. To fully appreciate the text, considerable preliminary reading should be done, and the author has very obligingly included a complete bibliography which serves for this purpose. As one reads along there is a keen interest developed. There are unlimited numbers of new ideas advanced, and one is somewhat reminded of the Emersonian style by the short powerful sentences so well chosen.

Super-Power as an Aid to Progress. By Guy E. Tripp. New York: G. P. Putnam Sons, 1924.

It is a rare treat to review the published work of one of the directors of the Army Ordnance Association. Brigadier General Guy E. Tripp, author of "Super-Power as an Aid to Progress," has been an ardent worker in the cause of industrial preparedness and an active official of the A. O. A. for years. He served with distinction as an assistant to the Chief of Ordnance during the World War, and his interest and enthusiasm for all things promotive of munitions preparedness have not diminished in these "piping days of peace."

The relation of "super-power" to national defense has already been discussed in these pages by the author (Army Ordnance, Vol. IV, No. 20, page 75), and this article forms the concluding chapter of the book. The volume itself is a collection of articles which point out in glowing terms the advantages to be gained from the increased development of hydro-electric and steam power plants and the increased use of electricity. The author advocates a centralization of electric producing units and an interconnection of adjacent power systems. The advantages which will accrue from development along the lines indicated are of undoubted value. This development is being gradually brought about at the present time, as is pointed out by the author, in the case of the Southern power companies.

While the author objects very decidedly to government ownership and operation, there is much to be said on both sides of this question. Perhaps the cheapest power would result if the government financed all the hydro-electric development and charged the cost off the books in the same manner as the States now do when they build public roads.

For those who are interested in this important subject—and certainly all readers of ARMY ORDNANCE should be—we take pride and pleasure in recommending General Tripp's book.

The Constitution of the United States: Its Sources and Its Application. By Thomas James Norton. Boston: Little, Brown and Company, 1922. 298 pages.

Undertaken with the express idea that it be different from most commentaries on the Constitution, this book *is* different from the great mass of writings on our highest law. The author says of it: "The purpose of this book is to make accessible to the citizen and his son, to his newly enfranchised wife and daughter, and especially to his children in school such a knowledge of the Constitution of the United States as will serve in emergency as a "first line of defense." Further, "The simple plan here is to explain the Constitution by a note to every line or clause that has an historical story or drama in back of it, or that has contributed during the one hundred and thirty-three years of our life under this instrument to the national or the international welfare of mankind. This method leaves the text of the Constitution and the Amendments in unbroken connection, so that the whole great design is visible, and the explanation appears immediately under the part to be explained."

The author has followed this plan throughout. Naturally then there is a wealth of historical data that is not often gathered in one place—certainly it is not always so copiously referred to and explained in works on the Constitution. Thus this book really fulfills a two-fold objective.

Take, for example, the treatment of the second clause of Article I, which prohibits Congress from abridging the freedom of speech or of the press. Here the author goes back to Hallam's *Constitutional History of England* and traces from the time of Henry VIII, through Blaekstone and the Acts of Parliament, on through our own early federal legislation, and concludes with a discussion of the Espionage Act of 1917. And all this in the course of six short pages. The same thorough and concise treatment is given every clause of the Constitution.

Can any one now plead a lack of means for not being conversant with every important provision of the Constitution? Here is a real treatise on Americanization that every real American would do well to study. By studying it the young may drink in for the first time, manhood and womanhood may revive and consider, and the aged may contemplate with serene confidence those supreme principles which have guided us on the perilous journey of statehood.

Doubly appropriate is the quotation from Gibbon, with which the author prefaces his book: "Civil governments, in their institution, are voluntary associations for national defense. To obtain the desired end it is absolutely necessary that each individual should conceive himself obligated to submit his private opinion and actions to the judgments of the greater number of his associates."

The State of the Nation. By Albert J. Beveridge. Indianapolis: The Bobbs-Merrill Co. Price, $3.00.

Since public opinion is the court of final appeal on all questions affecting our government and its administration, it is highly important that the average citizen should have the facts on which to base an intelligent and patriotic judgment. He may be misinformed or ignorant of the real issues of the day. He may be biased in his judgment of partisan zeal, and misled by political demagogues, but the average voter generally desires to meet his obligations as a citizen honestly. This book deals with vital questions and is written in a clear, simple, limpid style which will appeal to the man in the street.

Six great questions are discussed. First, our foreign relations. Shall America go into the World Court? The author is strongly opposed to such a step. The reader may not agree with him, but will concede that he states his reasons strongly and clearly. The second chapter discusses the present crusade against the Supreme Court of the United States, on account of the "Five to Four" decisions which have issued from that great tribunal. The author reviews the history of the court and makes a strong statement of its relation to the permanence of our institutions, and points out a way by which its ancient prestige may be preserved. The third chapter deals with the evolution and expansion of the railroads of the country and the problems of government control of them, the danger of government ownership toward which we are drifting, and an argument for preventing such a catastrophe. The fourth chapter deals with the present multiplication of government bureaus, which the author claims are paralyzing our national initiative, handicapping business and increasing the expenses of government at an enormous rate. The fifth chapter, entitled "Mr. President," is an interesting survey of the work of the nation's Chief Magistrate, "our general manager," as he defines him, and a plea for the selection of strong men for the office rather than the colorless type who have so often been selected for political reasons. The closing chapter is an address before the New York State Bar Association on "The Supremacy of the Supreme Court," a subject in which the author is vitally interested.

To the discussion of each topic, Mr. Beveridge has brought a mass of information which will be illuminating to the general reader.

Robert E. Lee: An Interpretation. By Woodrow Wilson. Chapel Hill, N. C.: The University of North Carolina Press. 42 pages. Price, $1.00.

This is a prophetic address, delivered by the late ex-President at the University of North Carolina, January 19, 1909. Brilliancy of style and thought abound throughout this interpretation of a great man by one whom future generations may herald with even greater acclaim.

A proper appraisal of this essay demands a reading and then a period of thought. Then one is struck by the prophetic—providential, if you will—message it carries.

The university, in bringing out the book at the time, has this to say about it: "In setting forth, in 1909, the principles which dominated the life of the great leader of the Confederacy, Mr. Wilson, unconsciously perhaps, but none the less actually, revealed the fundamental principles which governed himself while shaping the destinies of the nation in

its supremely critical hour and fortified him in his self-sacrificing effort to secure for humanity an enduring covenant of understanding and good-will.'' That this is true, witness but the peroration of the address itself: ''I wish there were some great orator who could go about and make men drunk with this spirit of self-sacrifice. I wish there were some man whose tongue might every day carry abroad the golden accents of that creative age in which we were born a nation; accents which would ring like tones of reassurance around the whole circle of the globe so that America might again have the distinction of showing men the way, the creative way of achievement and of confident hope.''

Of the eulogy of Lee, we can say—with the late President—''In one sense it is a superfluous thing to speak of General Lee—he does not need the eulogy of any man.'' Nevertheless, on this occasion an eulogy was delivered that bids fair to last as long as the memory of the speaker and the subject of his theme.

Mobilizing for Peace. Addresses delivered at the Congress on America and the Permanent Court of International Justice. Edited by Frederick Lynch, D. D., Educational Secretary, World Alliance for International Friendship. New York and Chicago: Fleming H. Revell Company. Price, $2.00.

This book is indeed an assemblage of influential opinion on ways and means of furthering and maintaining world peace. The addresses were delivered by such eminent clergymen as William Pierson Merrill, Charles E. Jefferson, William Adams Brown and Bishop James Cannon, Jr.; such prominent educators as A. Lawrence Lowell, Mary E. Woolley and Manley O. Hudson, and such publicists as Will Irwin, Edward L. Beach, U. S. Navy, retired; Oscar Straus, Raymond B. Fosdick, Fred B. Smith, Alice L. Parsons and a number of others from America, together with a number of messages from various foreign countries.

If one wants to know something of what is going on in the churches to bring about ''world organization to replace trial by battle with trial by jury and to outlaw war,'' we could not do better than refer him to this volume. Certainly the forces of Christianity and Judaism have never before attempted such a program of mobilizing every resource for outlawing war and educating the conscience of the world as is indicated in these thirty-five addresses. As was probably to be expected in such a volume, the necessity for military preparation to maintain peace is not dwelt upon. The object of these writers and workers is to arouse the conscience of the world on the subject of war and to appeal to the reason of men to see the way of arbitrating all differences in a court of law rather than the field of battle.

Contemporary French Opinion on the American Civil War. By W. Reed West, Ph. D., Johns Hopkins University Studies in Historical and Political Science. Series XLII, No. 1. Baltimore: The Johns Hopkins University Press. 9 chapters, 152 pages. Price, $1.50.

The Civil War as an event has always filled the minds of Americans. Most of us are familiar with the episodes of that great struggle. However, few are acquainted with the opinions and activities of the great nations of Europe during this critical period in our history. Probably few know also that the neutrality of the maritime powers made possible victory for the Union. If any one of these powers had joined the South, the Union would have been lost. Fortunately, neutrality was preserved by some means and the Union was saved.

It, therefore, becomes a matter of great interest to trace the mutations of public opinion on the American Civil War in one of these great powers, especially where it bore upon the important question of neutrality. The author has selected France as his subject. Newspapers, debates in the legislature and other sources of like nature have furnished the materials for the monograph. Nine chapters are devoted to opinions on various phases of the relations of France with the American continent. It is conclusively shown that neutrality was stretched to the breaking point on several occasions. It is really surprising that the neutrality of France was preserved at all.

To the reader who would learn what a great European power thought of the Civil War and its far-reaching economic effects, this monograph may be recommended.

The Profession of Arms. By Elbridge Colby, Captain, U. S. A. New York: D. Appleton & Co. 15 chapters, 183 pages. Price, $1.50.

Soldiers have figured prominently in the affairs of every civilization since the dawn of history. The quality of the fighting men has always determined the rise or fall of each. Behind the resolute bravery of soldiers, empires have risen; their fall has coincided with the degeneration of the military spirit.

Since the military profession has exercised so important an influence on the history of mankind, it is surprising that more has not been written on the ideals and motives of the calling. Captain Colby has pioneered in this field in this interesting little volume dealing with the profession of arms, as exemplified in our own army.

The volume is begun with a description of the Army and its functions, the military policy of the United States, some pertinent notes on the qualifications of a good officer, means of obtaining a commission, the duties of an officer and other matters of general interest. Modern battle is described in another chapter. Several chapters are then devoted to descriptions of the functions of the various branches of the Army. A fitting conclusion is provided in a stirring chapter dealing with the spirit of service in the Army and the compensations of a military career in return for the sacrifice of possible fortune in civil pursuits.

The author has acted as an interesting spokesman for the military profession of our country. His book is well worth reading by the general reader who would know more of the motives, sentiments and work of the men composing the Army of the United States.

Atoms and Electrons. By J. W. N. Sullivan, Scientific Editor *The Nation*. New York: The George H. Doran Co. 185 pages. Price, $1.25.

This book is one of a series, entitled ''The Modern Readers' Bookshelf,'' gotten out by the publishers, ''to bring together in brief stimulating form a group of books that will be fresh appraisals of many things that interest modern men and women.'' The style, topics and general format are pleasing and attractive.

''Atoms and Electrons'' has qualities of varigated hues, extending from the infra-red to the ultra-violet. At the one extreme is its nth degree simplicity, at the other its up-to-dateness. After all, these are no mean topics to discuss, and to achieve simplicity of style and thought in dealing with quantities that are infinitesimally infinitesimal is certainly a virtue rather than a fault. Remembering, too, the general purpose of this and the other volumes of the series, this book shou'd appeal to the average reader who has no time to bother with the entanglements of pure science just to get a composite idea of these things everybody is talking about.

The newness of the subject matter makes this book the last popular word on the present status of atomic research. The theories and findings of Einstein, Mosley, Sommerfield and Debye, and their highly technical accomplishments, are discussed and explained with a lucidity that makes the book not only the handy and concise talk on a fascinating subject that it is, but also an initiator of thought that stands in awe at the great possibilities further study of atoms and electrons may hold for human kind.

Dynamic Psychology. By Robert Sessions Woodworth, Ph. D., Professor of Psychology, Columbia University. New York: Columbia University Press. 8 chapters, 206 pages. Price, $2.00.

In this work the author devotes his opening chapter to a brief history of psychology, describing the influences which have been at work upon this branch of learning during the past century.

The second chapter branches out into a survey of the problems and methods of psychology. It points out the shortcomings of the introspective and behavioristic methods considered individually, and suggests that neither should be accepted to the exclusion of the other. The suggestion is made that the results obtained by both of these and the results of brain psychology as well should be utilized in order to obtain an understanding of the complete processes of mental activity and development.

The succeeding chapters take up the study of psychology

from the dynamic point of view, and include a comprehensive arraignment of McDougall's Social Psychology.

This little volume presents the subject from an interesting viewpoint, and should be a valuable addition not only to a student's library, but to that of a layman who desires to obtain general information on modern psychology.

Artillerie de Campagne. By Lieut. Col. Rimailho. Paris: Gauthier-Villars et Cie. 506 pages.

The author presents an historical study of mobile artillery matériel covering the periods of development of artillery in France from 1870 up to the present time. The history is divided into four periods, according to the outstanding progress in the development, as follows:

1. French artillery after the War of 1870 up to the development of the present 75-mm. gun.
2. From the development of the 75-mm. up to 1914.
3. Artillery matériel of the World War.
4. Artillery matériel of the future.

Proceeding from the very slow development of artillery from 1870 up to about 1895, the author emphasizes the very radical development of the hydro-pneumatic brake which was first successfully used in the French 75-mm., model of 1897. This development is considered most important, as it assured for the first time rapidity of fire with smoothness of action, and at the same time permitted the matériel to be built within suitable weight limits to permit easy maneuvering of the carriage.

The development of all calibers of artillery during the war, from 1914 to 1918, stresses the progress of development of rapid fire weapons such as the light mortars and the requirements which led to the development of heavy mobile artillery, including a brief description of types up to railway mounts. In this period the author also touches on the development of the tank.

The greater portion of the book is devoted to a discussion of artillery types of the future, together with a discussion of the national organization desirable in France to carry out such development. The types of artillery are divided according to their tactical use, beginning with the infantry cannon and covering all classes up to railway artillery. Details of design are confined to St. Chamond post-war types of all calibers. The divisional artillery is stressed particularly, as apparently the greatest progress has been made in that, and it is regarded as the most important. However, some novel ideas of antiaircraft artillery mounts are presented.

In the development of self-propelled mounts and tanks, the use of both caterpillar tracks and wheels is made in practically all models. The wheels are mounted beyond the ends of the caterpillar track and are so arranged that they can be folded up out of the way when the tracks are being used.

The book presents a complete discussion of artillery development, as carried out by the St. Chamond Company, and is an interesting study of artillery development for the designer of artillery matériel.

Shot Guns. By Major Hugh B. C. Pollard. London: Sir Isaac Pitman & Sons, Ltd. 8 chapters, 122 pages. Illustrated. Price, $1.75.

The author presents a summary of the evolution of the modern shot gun, together with descriptions of various types now in use. There are included also some data on the ballistics of the shotgun, various methods of boring the barrel and some remarks on shooting equipment in general and sportsmanship in the field.

The outstanding characteristic of the book is its eminently British point of view. While the author concedes some virtues to the arms produced in the United States, he admits that those made in England are without equal. It is no doubt true that English shotguns from the better makers are very satisfactory; it is believed, however, that some of those made in this country are quite as good, both in shooting qualities and finish.

Shooting in England differs very materially from what we are used to here, because of the practice there prevalent of driving game. The shooter picks, or is assigned to, a stand, and often never leaves it during the entire day. He usually has two guns, and is served by a loader. Such a practice is almost unknown in the United States. As a result there has been evolved a type of shotgun using a minimum load, which is exceedingly light and handy. Such a gun is well adapted to shooting driven game. The sportsman may fire several hundred rounds in a day with little fatigue and no unpleasant results. It is not so well suited to what may be called the American style of shooting, where long shots are more likely to be taken, requiring a heavier load, and if recoil is not to be unpleasant, a heavier gun.

The book contains a number of tables showing various bore dimensions, shot sizes, velocities of various standard English loads, etc., and is especially worth while for these to the amateur of the shotgun.

Foibles and Fallacies of Science. By D. W. Hering, Professor Emeritus of Physics, New York University. New York: D. Van Nostrand Company, 1924. xiii, plus 294 pages. Price, $2.50.

Each of us has his pet foible or fallacy, generally of a scientific trend. There are many now living who believe implicitly in long-distance weather forecasts; palmists flourish; there are still seekers after perpetual motion; rainmakers still obtain employment. The scientist usually laughs at the more obvious fallacies, but often has his own, more specious and less easily disproved because more camouflaged by scientific terminology.

After an excellent introduction, the author deals with better known foibles and fallacies of this and other ages. Astrology, almanacs, the transmutation of metals, perpetual motion, the divining rod, prophecies, palmistry, El Dorado and such like subjects are dealt with in a manner to absorb the attention; and an excellent bibliography makes it possible to follow still further any chosen subject.

Business Fundamentals. By Roger W. Babson, Business Statistician, with foreword by B. C. Forbes. New York: B. C. Forbes Publishing Company. 18 chapters, 258 pages. Price, $2.00.

The author of this book is well known as the head of an organization which collects business data, tabulates this data in statistical tables, interprets the statistics and distributes the conclusions to its clients in the form of reports, forecasts and charts or graphs, which show the status of business in the past and indicate its future course.

In this work the author takes the reader behind the scenes, into his plant, and reveals the broad principles upon which the course of business depends, and points out the specific sources of data which are most dependable in indicating its future.

First, asserting that business conforms to laws as exact as those of physics and chemistry, the author shows how these laws may be read between the lines, or rather, between the columns, of statistical data. However, the phenomena of business are traced back to a moral, social and religious basis, a field in which exactness is not so prominent as in physical sciences, and the complete data is not so readily obtained. So the skeptical one can well believe that the laws of business and the art of applying them could be more readily compared to meteorology; not doubting that both business and the weather depend upon laws, but doubting that sufficient data can be collected to exactly predict the future. The author's own attitude is revealed by frequent use of the word "barometer."

In addition to laying down general principles, this book shows ways of handling specific problems of purchasing, management, marketing, investment, advertising, et cetera. The principles and advice enunciated are of value alike to the business man or executive, the large investor and the salaried individual who is trying to build up a competency against old age.

In no chapter of the book does the author permit the reader to forget that the work is a sales talk for the "commodity" which his organization has to sell, i.e., charts and reports showing the future course of business.

The Economics of Overhead Costs. By J. Maurice Clark. Chicago: University of Chicago Press. 24 chapters, 487 pages. Price, $4.00.

Much has been written and said concerning overhead costs in industry, but the conception varies widely according to the actors which are allocated to overhead costs by the individual who is called upon to deal with the subject. The author in beginning a research of this important economic principle has defined the subject as that of costs which can not be traced to units of output or which do not vary with the output. With this definition as a point of departure, the author then develops overhead costs as a phrase of "dy-

namic economics,'' which in turn may be termed a study of the discrepancies between ever fluctuating demand and a fixed fund of productive capacity. These discrepancies create the unused capacity for production, which accounts for many economic disturbances.

The argument is well sustained throughout the book. Apparently every effort has been made to produce a readable text which can be of use to the business man as well as the student of economics. The principles developed are readily applicable to the problems arising in the industrial world. It is a pleasure to find an economic treatise which can be so applied. Too often there is little of constructive value to be found in such books.

This book should prove a valuable reference work for the industrialist who would apply to his actual business sound principles of economics covering the important element of overhead costs.

Nitrogen Survey. Prepared under the direction of Dr. Harry A. Curtis, Chief, Nitrogen Division, U. S. Department of Commerce. Issued in five parts as supplements to Commerce Reports. Published by the Bureau of Foreign and Domestic Commerce.

Parts I and II of the report on the nitrogen survey conducted during the past year by Dr. Harry A. Curtis, Chief of the Nitrate Division of the Bureau of Foreign and Domestic Commerce, and Professor of Chemical Engineering at Yale University, have now been published and distributed. This report, appearing in the form of trade information bulletins, is prepared as part of the investigation of essential raw materials authorized by the Sixty-seventh Congress. The three remaining parts now in the course of preparation will soon appear.

In making this survey, practically the whole world was covered, questionnaires sent to all United States commercial attachés and trade commissioners and to the various agricultural colleges and experiment stations. The more specific items of the survey were studied in the field by special representatives. Chilean nitrate was studied by one of these representatives, the Director of the Bureau of Mines, who spent the summer of 1923 in the field visiting the various mines and officinas of Chile. The rôle of nitrogen in American agriculture was the topic of the field investigation by another special representative, while a third investigated the air nitrogen fixation industry by consulting with specialists and inspecting the plants of interest in Western Europe.

Part I, ''The Cost of Chilean Nitrate,'' discusses the mode of occurrence and mining conditions, treatment and recoveries, costs and nitrate reserves. It points out that while a change in the tax system and the effecting of certain economies might result in a reduction in price ex-ship in United States ports to as low as $30, for short periods, and $35 for longer periods, yet an increase in price might be expected without these changes.

Part II, ''General Survey of the Nitrogen Situation in the United States,'' covers the subjects of the relation of nitrogen to food production in the United States, nitrogen from coal, fixed nitrogen from animal and vegetable sources, the air nitrogen industry in the United States, Chilean nitrate and consumption of fixed nitrogen in the United States.

Part III is a summary of general technical information and cost data concerning the various air nitrogen processes. It discusses the possibility of improvements in the existing processes and also the adaptability of the processes to conditions in the United States.

Part IV will cover the nitrogen situation of the world. This part will be somewhat historical and will cover to an extent the past, present and expectations for the future in nitrogen for the various countries of the world, as to production, importation, exportation, consumption and war plans.

Part V, which is being prepared jointly by Dr. Curtis and the technical staff of the Fixed Nitrogen Research Laboratory, will be a complete nitrogen bibliography.

By publishing the report in five parts, those interested in but one phase of the subject can have that part separately, while those interested in the subject as a whole can bind the five parts together and have perhaps the most complete and valuable general treatise on nitrogen yet published.

Export Credits and Collections. By Gordon C. Poole. New York: Prentice-Hall, Inc., 1923. 180 pages; flexible binding. Price, $4.00.

The passing of time seems to put to flight more and more theories concerning the old-established doctrines in nearly all lines of endeavors. It is, of course, a far cry from our present day economics to those of Adam Smith. And yet the relation between his day and ours—by way of contrast—is itself interesting.

Writing in his *Wealth of Nations*, on the methods of the Scotch bankers in checking the credit status of their loans, he says: ''A private man who lends out his money to perhaps half a dozen or a dozen of debtors, may, either by himself or his agents, observe and enquire both constantly and carefully into the conduct and situation of each of them. But a company which lends money to perhaps five hundred different people, and of which the attention is constantly occupied by objects of a very different kind, can have no regular information concerning the conduct and circumstances of the greater part of its debtors beyond what its own books afford it.''

Would that the shade of Adam Smith could brouse through this treatise by Mr. Poole and become initiated into the highly systematized procedure of the foreign credit manager. The shade—were he the conscientious shade history accredits the man—might ask that ''Export Credits and Collections'' be made an appendix to his own ancient and honorable—and at times old-fashioned—Doomesday Booke of economics.

As the name signifies, Mr. Poole's work is a complete dissertation on export credits—a subject of growing importance to the American manufacturer. In true creditman style, Mr. Poole exhausts every possible topic connected with his subject. He expounds some theories which, in the nature of things, apply equally to the handling of domestic as well as foreign credits. He explains the customs, methods and meanings of everything connected with foreign credits and collections in an interesting and straight-forward way. He gives a complete outline of the duties and requirements of the work. His use of the regular trade forms and his explanations of them succeed in giving the reader a panorama of this important function of foreign trade. The make-up of the book is creditable to both author and publisher. We recommend it.

Economics for Everyman. By J. E. Le Rossignol. New York: Henry Holt & Co., 1923. vi, plus 334 pages.

As its name implies, this is an elementary treatise on economics for the general reader. It is scholarly and well written, with a wealth of apt illustrations. Not the least of its good qualities is the short bibliography which follows each chapter.

The treatment follows classical lines. The author makes no claim for originality, but he has succeeded in creating a very interesting work. As presented by Dean Le Rossignol, economics cannot justly be classified as a ''dismal science.''

The People's Corporation. By King C. Gillette. New York: Boni and Liveright. 237 pages.

''The People's Corporation'' adds another to the many schemes which have been brought forward during the past few years to correct all the evils in our present economic system.

The first half of the book describes in detail these evils, which the author traces back to the time when man first claimed ownership to property and succeeded in convincing his fellowman of such rights. This property right, which has fostered the acquisitive impulse of man, is claimed to be responsible for our present competitive system, in which every problem of capital expenditure for improvement in quality or product for increase in wages, etc., must be weighted against the probable box-office receipts.

The author is particularly bitter against what he considers the inefficiency of the present competitive system. He chalks up a series of black marks against the system, such as the large leisure class living in luxury on returns from capital investments; the much larger class which is occu

pied in what he classes as non-useful occupations, such as tradespeople of all classes, bankers, brokers, insurance agents, etc. These classes of business he refers to as mere "busyness."

By a combination of statistics and imagination it is finally concluded that our system is less than 30 per cent efficient, or, as the author expresses it, is more than 70 per cent inefficient.

Having fastened all the inefficiency of the present system on the right of man to own property, with the resultant acquisitive instinct, and found that large corporations were a step in the right direction towards increased efficiency, except that they operate for the benefit of the stockholders rather than for that of the general public, the author begins to develop his remedy, which is the People's Corporation, a single cooperative unit to control all production and exchange. Business transactions will be between the individual and the corporation only and never between individuals. To be effective this corporation must know no national boundaries, else there would be competition between nations. It must control all lines of endeavor to prevent competition between coal, oil, water power, etc. This corporation will be the only purchaser of labor and will be the only dispenser of goods. It will, through its statistical bureaus, ascertain just how much of each commodity will be required so that there will not be over production of some commodity and under production of others. In case general over production should result for a period, a grand holiday could be declared in place of the hard times which follow over production under the present system.

The organization of the corporation is worked out consisting of the corporate congress, following which come administrative officers, specialists, technical experts, etc., down to the unskilled labor. All must work their way up through the various grades, through examination and classification under direction of the Civil Service Division. Compensation of workers will be in work credits and everyone must work except children during their training period. When sufficient work credits are saved by an individual to keep him during life he may retire, and under the high standards of efficiency prevailing, it is estimated that a man will be able to produce sufficient in five years to keep him in luxury for his natural life of seventy years.

Such is the People's Corporation, which the author claims is not a Utopian dream but a practical plan designed to bring order out of chaos. This may be true, but it appears that in spite of the claim as to its practicability, the plan as outlined leaves considerable detail to be supplied. Great claims are made as to the system encouraging research and discovery, and rewards are held out for achievements of this character; however, the maximum reward can be nothing more than enough work credits to maintain one for the rest of his life. At least he can use nothing more, since he could not even provide additional comforts for his own family. He could accomplish the same by working an estimated time of about five years without risk or special labor. If bent on travel to enjoy himself, as suggested by the author, he must go alone, since he has nothing which he could offer a friend or companion to accompany him. There is apparently no provision for the infirm who are unable to work, but presumably under this highly efficient plan such would be put to death so as to prevent their being a drag on the system. Likewise those who had sufficient work credits, estimated to keep them through life, but these credits became exhausted due to longer period of life than anticipated at a time when they were no longer able to work would presumably be put to death so as to maintain the efficiency. Then, where would he get the experienced people to run the corporation? As to details, the scheme appears to be in about the same state as that proposed by a member of the Board of Aldermen of one of our thriving western cities, which had developed something of a traction problem due to its rapid growth. This member had discovered that a large item of operating cost of the car line was power, and that this line ran out a single street all on down grade. He, therefore, announced his practical plan to take over the traction line, eliminate the power plant and run it by gravity. When asked how he proposed to return the cars which had run down grade, he replied that that was one of the details to be worked out by the engineers. So with the People's Corporation, the scheme is all worked out. All that remains is the detail of getting the White man, the Black man, the Yellow man, the Brown man and men of all intermediate shades, as well as men from all classes and occupations within one color scheme to sit around a table containing a pie representing the entire resources of the world, and for them to agree on an equitable division of that pie.

It appears that the author's contribution would hardly earn any work credits under the efficient People's Corporation, and that he has been indulging in mere "busyness." During his temporary transfer from big business to the occupation of a writer, it is feared that the inefficiency of our system has been increased above its normal 70 per cent. If any great amount of time should be spent on this book by the reading public, the percentage would climb still higher unless that time might be charged to recreation, and it is well to remember that under the People's Corporation, with only five years required to lay up a competence upon which to retire, there will be many years of leisure for recreation, and apparently not even a "tired business man's show" provided to relieve the monotony on account of the efficiency expert being continually on the job.

Exporting to the World. By A. A. Preciado. New York: Prentice-Hall, Inc., 1923. 430 pages. Price, $5.00.

In the parlance of the day, this book is "the whole works" on exporting. And if Blackstone is essential for the lawyer and a materia medica for the doctor, then Mr. Preciado's book is a prime requisite for the exporter.

The author takes nothing for granted. The reader is introduced to the subject in its very fundamentals and is taken through every stage of the game. Of course, some chapters are head and shoulders above others, notably those on "American Banks in Foreign Trade," "Foreign Investments," "Marine Insurance," and "Foreign Credits." Other parts of the book are at times routine and uninteresting. But that is not the author's fault, nor do they detract from the value of the work; they are part of the complete explanation undertaken by the author. The value of such a work should be great to American industry. "America is beginning to think internationally" is the author's keynote. That thought will be translated into action by our manufacturers. American trading in foreign markets must and will gain, and American goods will be carried to the ends of the earth. What portion of this commerce has not already come will come eventually. Then we must know the mechanism of exporting. We know how to make the goods; we may not know how to export them. Here, then, Mr. Preciado's book will be of service, and those who turn to it will find a valuable treatise that will help guide them through whatever difficulties "exporting to the world" may bring.

Wealth and Income of the American People: A Survey of the Economic Consequences of the War. By Walter Renton Ingalls. York, Pa.: G. H. Merlin Co. xviii, plus 372 pages; Second Edition, 1923.

The present volume, from the pen of a past President of the Mining and Metallurgical Society of America and present Director of the American Bureau of Metal Statistics, approaches the task of evaluating the economic consequences of the World War from the viewpoint of the engineer rather than the professional economist. The present edition is the second, the first having appeared in 1921. A wealth of statistics has been marshaled in this work with what must have been almost infinite care.

After a discussion of the production of commodities during the period 1911-1920, he discusses the external position of the wealth of the United States and reaches the conclusion that our credits increased about 15.8 billion dollars from 1916 to 1920, our debts decreasing about 2 billion dollars during the same period. The question of our ability to collect all that is owing to us is raised.

The internal position is next discussed, followed by discussions on our intangible wealth, gains and losses as a result of the war, the Allies' debt, the division of wealth, the national income, the division of incomes, etc. Discussions are largely statistical. It is stated in the summary, "The world became enormously impoverished by the war, and * * * although the United States suffered less than any other country that was engaged, its position did not escape impairment. Consequently the people of the world are confronted with the prospect of a lower scale of living, which will be the case even in the United States."

Making Use of a Bank. By J. Anderson Fitzgerald, Assistant Professor of Business Administration, The Ohio State University. New York: Henry Holt & Company.

This is a very thorough treatise on the functions of the modern bank. Banking, it seems, in line with a great many other economic factors, has undergone a startling metamorphosis during the past half century. The mere borrowing and lending of money or the simple function of the safe-keeping of valuables was the germ from which has sprung the vastly complicated system of banking as we know it today. With this change has come the broader and more important application of the facilities of the bank to the individual depositors as well as to the needs of business and commerce. The bank of today, while in essence the same as the institution of the past, is yet extremely modernized; so much so that it is one of the most vital links in our whole scheme of economics.

Professor Fitzgerald treats his subject in a manner at once comprehensive and interesting. To the lay reader whose contact with the bank may extend only to a checking or savings account or to the occasional purchase of a bill of exchange, it will be a revelation. Much of the substantive discussion is, of course, familiar to a general extent. But the descriptions of the inner workings of the institution and the treatment of the various functions with which the layman does not come in contact are well done. Certainly a more general understanding of the subjects treated here would have the broadening influence of a better realization of the functions of a bank and the important place these functions have in modern life.

A Reference List of Bibliographies: Chemistry, Chemical Technology and Chemical Engineering. Published since 1900. By Julian Arell Sohon and William L. Schaaf, New York: The H. W. Wilson Company, 1924. 100 pages.

This book comprises a list, arranged alphabetically by subject, of bibliographies and books or published articles which contain either bibliographies or numerous references to the literature. Some of the more important bibliographies published prior to 1900 have also been included.

As an indication of the scope of this list, it may be mentioned that there are given 39 bibliographic references on colloids, 31 on corrosion, 15 on explosives, 60 on iron and steel, 12 on metallography and 9 on nitrogen fixation. The cross-referencing of items under various subjects is especially thorough.

The book should be of great value to research chemists, engineers and others who find it necessary to make more or less exhaustive searches of the literature of a given subject. It is regretable that the authors find it necessary to state that "On account of the high cost of publishing bibliographic material, it has been necessary to limit the size of the book."

Raw Materials for the Manufacture of Sulphuric Acid and the Manufacture of Sulphur Dioxide. By Wilfred Wyld. New York: D. Van Nostrand Company. xiii, plus 558 pages. Price, $10.00.

The manufacture of acids and alkali is the foundation on which the whole chemical industry of our times is built. Lunge's "Sulphuric Acid and Alkali" has long been recognized as the standard in this field.

The last edition of Lunge appeared in 1913, and his "Supplement" in 1917. A. C. Cumming has undertaken the editorship of the present revised edition. In the new edition there has been a rearrangement into parts and sections more in accord with modern developments. Each volume will be on a special subject, and by a separate author.

Volume I contains new matter in relation to the disposal of the by-products, mechanical furnaces, etc., together with many new illustrations.

The work is well arranged, and this new appearance of a true and tried old friend should be welcomed by all who have occasion to consult the masters.

The Condensed Chemical Dictionary. Compiled and edited by The Editorial Staff, Chemical Engineering Catalogue, Francis M. Turner, Jr., Technical Editor. New York: The Chemical Catalog Company, Inc. 533 pages; limp leather, with thumb index. Price, $6.00.

This book is made for service. The format, text and subject matter are presented in a way to be most helpful to the chemist.

The spelling used throughout the book is that adopted by the American Chemical Society. Under each heading is given: The physical properties of the substance, solubility, derivation, method of purification, grades, containers, uses, fire hazards, and railroad shipping regulations. The various texts for each substance are concise and reliable.

The editors and publishers deserve a great deal of praise for bringing out such an excellent work. It should be invaluable to the chemist, both in the laboratory and in the library. It is one of those pieces of apparatus without which it is impossible to get along.

Optical Glass: A Stagetic Raw Material

(Continued from page 426)

The arsenal also maintains an optical laboratory, where new designs are tested and the best methods determined of inspecting and adjusting optical instruments.

Strategic Importance.

Ample capacity is available in this country for normal peace needs in both optical glass and fire control instruments.

The development of the industry of instrument manufacture and optical glass manufacture at the time of the Armistice was such that all prospective needs for 1919 could have been met from domestic sources had the war continued. This was in part due to the fact that many of our needs had already been supplied by France and England, but there is no question but that we could have produced a surplus during the year 1919 had it been necessary.

It will, however, require considerable time for the industry to become developed to the point where it will meet maximum requirements, hence there will be a critical point in the first months of an emergency, especially in certain items. This critical period extends, in the case of certain items, up to nineteen (19) months from the date of placing of orders for manufacture.

As regards optical glass, it is estimated that domestic production can be made adequate for all needs within three months, provided the present facilities for its production are maintained by the manufacturers. The manufacturers must be encouraged to keep their plants in good condition and to keep alive the art of manufacturing glass. Giving them small orders for glass from time to time will assist in accomplishing this, likewise the increased tariff recently placed upon imports.

Germany, England, France and the United States can be entirely self-supporting as regards fire control instruments and optical glass, but all except the latter have to import some of the raw materials, such as copper. Italy is partially self-supporting, likewise Japan, Belgium and Holland. The other countries are quite dependent on foreign sources of supply.

Sufficient tariff protection should be given manufacturers of optical glass in this country to warrant domestic manufacture in competition with foreign concerns.

Recent Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

A number of patents on Ammunition have been issued recently, of which the following are probably the most important:

John B. Semple has been granted patent No. 1,494,718 for a projectile having a cavity closed at its forward end and open at its rearward end and a fuze within the cavity and located at the forward end thereof.

Patent No. 1,491,676, issued to Leon Courouble, for a shell in which the inventor aims to reduce the number of parts, to make the parts suitable for shells of various calibers, and to provide for transportation of the shell and its primer detonator separately.

Robert A. Hadfield and August B. H. Clerke have been granted patent No. 1,490,464 for an armor-piercing projectile. The main object of this invention is to so construct the rear end of an armor-piercing projectile as to prevent fracture of the shell when the shell strikes armor plate at an angle. This is accomplished by forming an annular groove in the rear of the shell in which may be placed a metal sleeve conforming substantially to the shape of the groove, which sleeve is held in place in the groove by means of a cover ring threaded into the groove.

Patent No. 1,492,905, Joseph G. Swanick, assignor to Columbia Salvage Corporation, is a method and apparatus for unloading high explosive shells. The method consists in inverting the loaded shell, that is, placing it nose downward upon a nozzle from which steam may be injected into the shell to melt the explosive therein and supporting the shell so that it may be gradually lowered by gravity as the charge within the shell is melted.

Thomas F. Knight, assignor to Columbia Salvage Corporation, has been granted patent No. 1,492,922 for method and apparatus for unloading high explosive shells. The method consists substantially in injecting hot water and air under pressure into the shell to dissolve or liquify the charge and force the charge from the shell, a separate pipe being provided for taking off the melted charge.

Thomas F. Knight, assignor to Columbia Salvage Corporation, has been granted patent No. 1,492,923 for method and apparatus for unloading high explosive shells. In the method covered by this patent the shell is inverted, nose down, and a steam nozzle is inserted in the shell, the steam ejected from the nozzle melting the charge in the shell, which melted charge flows out through the nose of the shell, the shell being moved downward as the charge melts and a uniform steam jet maintained at all times on the undissolved portion of the charge.

Thomas F. Knight, assignor to Columbia Salvage Corporation, has been granted patent No. 1,492,924, for method and apparatus for unloading high explosive shells. In this instance the shell is also supported nose downward and a nozzle from which steam and water is ejected is inserted in the shell, the steam and water dissolving the charge and the shell moved downward upon the nozzle as the charge is melted.

Patent No. 1,492,925 has also been granted to Thomas F. Knight, assignor to Columbia Salvage Corporation, for method and apparatus for unloading high explosive shells. In this instance the shell is supported nose downward and a steam jet inserted in the shell, this steam jet extends through a cup which is some distance below the shell and which is in communication with the interior of the steam jet through suitable apertures. The steam passing through the steam jet condenses to fill the cup partly with water, while the melted explosive falling down from the shell also enters the cup. The steam ejected from the jet will then carry some liquid from the cup into the shell, which, it is contended, will aid greatly in softening and melting the charge in the shell.

Gustave Allison, assignor to Columbia Salvage Corporation, has been granted patent No. 1,492,949, for ashell salvaging apparatus. This apparatus consists of a specific shell holder and a j-shaped nozzle supported so as to be moved up and down.

Richard H. Bots, assignor to Columbia Salvage Corporation, has been granted patent No. 1,492,956, for a method and apparatus for unloading high explosive shells. In this instance the shell is placed in an upright position, a discharge nozzle secured in the nose of the shell, and a steam nozzle inserted into the shell through the discharge nozzle, the steam nozzle being allowed to gravitate to the bottom of the shell as the explosive in the shell is melted by the steam.

Richard H. Bots, assignor to Columbia Salvage Corporation, has been granted patent No. 1,492,957, for a method and apparatus for unloading high explosive shells. In this case the shell is supported in an inverted, or nose down position, and a highly heated water spray, which is produced outside of the shell by a steam jet, also arranged outside the shell, is directed into the shell to melt the explosive therein.

Patent No. 1,492,958 has been granted to Richard H. Bots, assignor to Columbia Salvage Corporation for an apparatus for unloading high explosive shells. This patent covers the specific apparatus for carrying out the method outlined in the preceding patent.

The foregoing patents, issued to Columbia Salvage Corporation, assignee, appear to contain very little of patentable novelty over the old and well-known methods of unloading shells which have been in use for many years at various shell loading plants.

Etienne Harle has been granted patent No. 1,488,787, for an explosive and a process for its manufacture. This patent covers a primer mixture, in which lead azide has incorporated therewith fatty matters in the proportion of .05 to 20 per cent, the object being to secure an insensitive primer in which the priming power will not be reduced by the mixture of fatty matters therewith.

Captain John B. Fidlar, Ordnance Department, U. S. Army, has been granted patent No. 1,494,535, for propellant powders to be used in guns and howitzers. The main object of the invention is to secure a flashless non-hygroscopic propellant powder. The powder consists essentially of nitrocellulose, starch and di-nitrotoluene.

Artillery

Eustace H. T. D'Eyncourt and Frederick Skeens have been granted patent No. 1,488,746, for a gun mounting. The mounting covered by this patent is intended primarily for use in tanks or armored cars, and consists, essentially, of a bracket mounted on a pivot and adjacent to an aperture in the armor, so as to swing about a vertical axis, in which bracket the gun trunnions are mounted, carrying a hemi-spherical shield projecting into the aperture.

Bryan P. Joyce and D. A. Gurney, ordnance engineers of the Ordnance Department, have been granted patent No. 1,489,889, for a connecting means for axles of gun carriages. This structure is designed to permit vertical movement between the axle and housing, while preventing relative lateral movement of these two members, and also to permit the axle and housing to be bound together when desired.

B. J. Joyce, of Rock Island Arsenal, has been granted patent No. 1,492,690, for a gun carriage. This patent covers a specific form of pivotal mounting between the top and bottom carriages of a gun carriage, together with means for properly lubricating the same.

Thomas A. Conlon, of the Ordnance Department, has been granted patent No. 1,492,962, for a pedestal mount for guns. This patent covers an improved method of leveling the gun in a pedestal mount.

Eugene Hagenbucher, assignor to Fried. Krupp Aktiengesellschaft, has been granted patent No. 1,493,628, for a laying gear. The structure covered by this patent is one in which a hydraulic laying gear is used, and the object sought is to secure a very exact laying operation.

Major Keith F. Adamson, Ordnance Department, U. S. Army, has been granted patent No. 1,494,524, for a gun barrel. The structure covered by this patent is a jointed sectional gun barrel, and the patent covers the particular joint devised for connecting the sections together.

Patent No. 1,489,566 has been granted to the executors of Arthur Gordon Webster, deceased, for observing and recording the operation of ordnance. The object of the device covered by this patent is to measure and record with approximate accuracy the consecutive pressures and time of explosion in a gun.

Patent No. 1,491,815 has been granted to Robert V. Morse, for an optical lead computer for artillery. The structure covered by this invention provides means for multiplying the angular velocity of the target, the time of flight of projectile or other time interval, in order to obtain their product, which is the angular lead or deflection desired.

Oscar Grauheding, assignor to Rheinische Metalwaaren und Maschinenfabrik, has been granted patent No. 1,492,372, for an aiming device correcting for the inclined position of wheels or platforms. This device consists in providing a pointing circle having its axis located above the turning axis of the gun in obtaining the horizontal adjustment of the gun, a tangent sight having the arc of the radius positioned in the center of the gun trunnions, the sight provided with an axis for correcting the inclination of the trunnions with the axis of the bore of the gun.

Eugene Schneider, assignor to Schneider et Cie., has been granted patent No. 1,492,899, for an apparatus for applying corrections in the laying of artillery pieces from a distance.

Small Arms

Patent No. 1,489,989, issued to Lucius N. Diehm, assignor of one-half to Berkley C. Stone, for a fire arm. This invention relates more particularly to pistols and the main object sought by the invention is simplicity of structure.

Horace M. Hickam has been granted patent No. 1,490,272, for an aim indicator. The invention consists in a flash light adapted to be placed in the barrel of the firearm and having means for making electrical connection when the trigger is pulled, so as to project a beam of light upon the target.

A sight for machine guns is covered by patent No. 1,491,141, issued to Millard L. Johnston. The patent covers the specific means employed for retaining the sight slide at any desired position along the sight leaf.

John D. Russ, assignor of one-half to Wirt M. Russ, has been granted patent No. 1,491,635, for a revolving firearm. The patent covers a means for closing the gap between the revolving cylinder and the breech of the barrel at the instant of firing to prevent the loss due to escape of gases through the gap.

Oren M. Beach has been granted patent No. 1,494,407, for a small arms practice apparatus. The apparatus covered by this invention is a dummy pistol, the grip of which has a movable member, which may be squeezed by the fingers to vary the pull required to trip the trigger.

W. R. Bull of Springfield Armory, has been granted patent No. 1,487,312 for a flash hider having an inner and outer casing with staggered apertures and a heat absorbing medium interposed between the casings.

A. Coenders has been granted patent No. 1,487,722, for a firearm in which the barrel is normally in a forward position and is retracted by a spring when the trigger is pulled, the cartridge being fired just before the barrel reaches its rearmost position through means of a hammer operated by a plunger attached to the barrel. The cartridges are carried in a magazine of the revolver type.

J. D. Pedersen has been granted patent No. 1,487,799 for a hammer trigger mechanism for firearms provided with a breech closing bolt mechanism. He has also been granted patent No. 1,487,800, a mechanism for effecting and safeguarding the operation of feeding cartridges out of the magazine to the loading-in mechanism of the firearm. The same inventor has been granted patent No. 1,487,801 for a firearm using long range and short range projectiles. The arm is provided with separate barrels and separate magazines for the two classes of ammunition; and the mechanism is so arranged that either class of ammunition may be fired alone or the two together.

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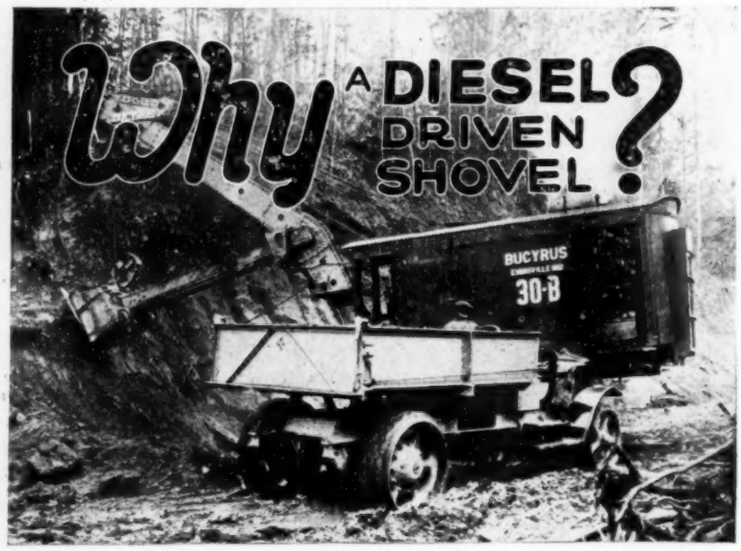

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